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To promote inter-disciplinary research in the field of agriculture and provide a forum for expressing views on policies and programmes relating to agricultural development

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A STUDY ON QUALITATIVE ASPECTS OF AREA RECORDED IN REVENUE LAND RECORDS (KHASRA REGISTER)

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ABSTRACT

In India land use statistics under nine fold classification is being collected through complete enumeration in most of the states except Kerala, Orissa and West Bengal. In these three states statistics are collected by selecting 20% villages through random selection procedure. Further, these villages are completely enumerated for collection ol statistics. Ihe quality of these statistics is a topic of debate during discussions among planners and researchers in the field of agricultural research and development. In order to assess the quality of these statistics in a scientific and objective manner a study was taken up in Lalitpur district of UP in rabi season of 2001-2002 to study the qualitative aspects of land use statistics as recorded by village level worker (patwari) in revenue land records (khasra register). Survey number wise area under different land use categories as compared between revenue land records and ground truth survey (field survey) in randomly selected villages. Results revealed that the area recorded in the revenue land records is reliable after aggregation at the upper level i.e. village and above but there were variations at individual unit level i.e. at survey number level.

Key words : Revenue land record, Cadastral map. ground truth survey, data quality.

The need for optimizing land use in an integrated manner has become particularly relevant in recent years as a consequence of compelling and conflicting demands of growing population. increasing land degradation and thus sharply declining man land ratio. It is general feeling that due to cost and organizational constraints of agencies engaged in collection of land use statistics, quality of data is deteriorating and also there is a considerable delay in brining out results, which greatly hempers efficient planning process. Data on land statistics being collected by village level worker (patwari) has been the subject of discussion for quite some time and question have been constantly raised over the quality of data mainly due to overburden of these workers. This study was taken up in Lalitpur district of Uttar Pradesh during *rabi* 2001-04 for assessing data quality of land use statistics through a scientific and objective approach.

MATERIAL AND METHODS

Lalitpur district is divided into three tehsils i.e. Talbehat. Mahroni and Lalitpur which were treated as stratum. The district consists of 754 villages. A total of 20 villages were selected using stratified random sampling design, following proportional al location (Hubback 1927. Mahalanobis 1940, Sukhatme and Panse 1951 and Arbia, 1993). Data of one village was not considered for the analysis due to non availability of revenue land record, therefore, a sample of 19 villages were allocated to these tehsils in proportion to the number of villages in each tehsil. The copy of revenue land record and cadastral map of the selected villages were obtained. The land use data falling under standard nine fold land use classification for each survey number of each selected village was independently collected through ground truth survey (field survey) by vell trained field investigators using village cadastral map.

RESULTS AND DISCUSSION

Mean and standard error (S.E.) for broad land use classification were calculated village wise for both sources i.e. revenue land record and field survey (Table l). A normal test of significance was applied for testing difference of mean between average area of the survey numbers recorded in revenue land records (khasra register) and ground truth survey (field survey). The results revealed that value of test statistics (t) was found to be non-significant at 5% level of significance for all selected villages. The overall test statistics after pooling all the survey number of the selected villages was also not found to be significant at 5% level of significance. This clearly indicates that the information recorded in revenue land records and ground truth survey records are statistically close to each other. This can also be concluded that land use statistics recorded in the land records are statistically close to true values.

Relationship between revenue land record and ground truth survey (field survey)

A simple regression model was fitted between revenue land records and ground truth survey (field survey) data for each class of land use. The area recorded in revenue land records were taken as independent variable and ground truth survey data were considered as dependent variable. The survey number wise regression analysis was performed on the data of each village and also relationship on pooled data for all the villages for each class of land use was studied. The area under crop was divided into two categories mainly (i) Irrigated crop area and (ii) Unirrigated crop area. The following regression model was fitted using ordinary least square technique:

$$y_i = a + \beta x_i + e_i \qquad E(e_i) = 0,\ V(e_i) = \sigma^2$$

where y, is ground truth survey (field survey) observation and x is corresponding observation of revenue land records.

The results in Table 2 provide information about coefficients and R_2 for different land use statistics classes for pooled data of all villages. It can be seen that value of R_2 is above 0.60 for

Table 1. Village wise statistics of area recorded in revenue land records and ground truth survey (field survey) records

Village	Revenue land records			Ground truth survey records			t-
	No. of Obs.	Mean	S.E.	No. of Obs.	Mean	S.E.	value
Agori	1509	0.4305	0.0188	1509	0.4305	0.0187	0.000
Balna	877	1.2889	0.6451	877	0.6452	0.0424	0.996
Bangarua	952	0.5086	0.0263	952	0.5086	0.0263	0.000
Bar	5269	0.7072	0.2567	5269	0.7073	0.3537	0.000
Bastguan	2638	0.2317	0.0078	2638	0.2317	0.0078	0.000
Dawni	3335	0.9756	0.0212	3335	0.9756	0.0212	0.000
Dhawa	1074	2.3900	1.1957	1074	1.1900	0.0545	1.000
Giltoura	488	0.8101	0.0636	488	0.8101	0.0636	0.000
Gundrapur	1671	2.0650	1.0320	1671	1.0330	0.0376	0.998
Jamunia	593	0.9871	0.0754	593	0.9826	0.0754	0.041
Kargan	1999	0.3696	0.2767	1999	0.3799	0.4230	0.872
Khajuria	1968	0.5057	0.0148	1968	0.5057	0.0148	0.000
Myao	2935	2.2784	1.1400	2935	2.2777	1.1396	0.0004
Naharkalan	1538	0.5134	0.0213	1538	0.5134	0.0213	0.000
Nathikhera	4138	0.8022	0.4013	4138	0.3974	0.0160	1.000
Padariya	714	0.5792	0.0347	714	0.5792	0.0347	0.000
Pipriya	877	1.2880	0.6450	877	0.6451	0.0424	0.996
Thana	2348	0.5603	0.0341	2348	0.5603	0.0341	0.001
Udgawan	1061	0.6756	0.3379	1061	0.3372	0.0162	0.999
Over-all	35984	0.9259	0.1289	35984	0.7448	0.1092	0.017

Table 2. Regression models for different land use classes

Land use classes		Constant	Reg. Coff.	R^2
Forest land		0.0297	0.9961	0.9972
Barren and un-culturable land		0.0522	0.9946	0.9593
Land put to Non-agricultural use		0.0024	0.9967	0.9940
Permanent pasture and other grazing land		0.0536	0.9967	0.9991
Culturable waste		0.0611	1.1331	0.5908
Current fallow		0.1587	0.9672	0.9244
Fallow and other than current fallow		0.1676	0.8870	0.6250
Net area sown		0.2074	0.8242	0.6225
Crop area	(i) Irrigated	0.0636	0.7984	0.6763
	(ii) Un irrigated	0.0312	0.7138	0.8393

all land use classes and it is above 010 for most of the classes. This clearly shows that, there is strong linear relationship between two sources of data. It can be concluded that the quality of land use statistics collected in land records are quite reliable. Further, using these regression models, quality of land use statistics collected through land records can be further improved.

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EFFECT OF ECO-FRIENDLY MODIFIED UREA MATERIALS AND NITROGEN LEVELS ON GROWTH AND PRODUCTIVITY OF AROMATIC HYBRID AND AN AROMATIC HIGH YIELDING VARIETY OF RICE

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ABSTRACT

A field experiment was carried out to find out the effect of eco-friendly modified urea materials and nitrogen levels on growth and productivity of an aromatic hybrid and aromatic high yielding variety of rice. The treatments consisted of 2 rice varieties (Pusa 1121' and 'PRH 10'); 4 N levels (0, 50, 100 and 150 kg N/ha) and 3 N sources (prilled urea, neem bitter coated urea and Pusa neem golden urea). The experiment was laid out in factorial randomized block design with 3 replications. The result of this study showed that the significantly higher values of growth parameters viz. tillers/ hill, leaf area index at 30, 60 and 90 days after transplanting and also dry matter accumulation at the same growth stages were recorded with an aromatic hybrid 'PRH 10' compared to a high yielding aromatic rice variety 'Pusa 1121'. Similar results were also recorded with yield attributes viz. panicles/ m2, panicle weight, panicle length, filled grains/panicle, 1,000-grain weight and also grain and straw yields. With each successive increase in the N levels up to 100 kg/ha, there were significantly increase in the growth parameters, yield attributes and yields of rice. Among the 3 N sources both the modified urea materials i.e. neem bitter-coated urea and Pusa neem golden urea were observed better than prilled urea with rice growth parameters, yield attributes and yields.

Key words : Aromatic hybrid, aromatic high yielding variety, N levels, neem-coated urea, growth, yield attributes, yields.

Rice (*Oryza sativa* L.) is the staple food for nearly 40% of the world's population. Approximately 9% of the world's rice are grown and consumed in Asia (Kumar and Prasad, 2004), the continent that absorbs the major share of the global population increase. Bains *et al.* (1971) were the first to report increased nitrogen use-efficiency (NUE) due to treating urea with ethanol extract of neem seed. Scientists at Indian Agricultural Research Institute (IARI), New Delhi, India have reported the nitrification-inhibiting property of neem and neem cake coated urea (NCU) was developed and found to have higher NUE than prilled urea alone; the farmers have accepted this technology. Scientists at IARI have also experimented with neem-oil, and a urea neem-oil product (10% by weight) was developed and found superior to prilled urea for rice (Bharde *et al.*, 2003); this product is termed as Pusa neem golden urea (PNGU). Recently scientists at the IARI have developed a new neem-coated material i.e. neem bitter-coated urea however its efficacy to increase the NUE are not known. Agronomic practices for aromatic hybrid rice are different from inbred rices because of its genetic variability. In order to tap yield potential of newly-developed rice varieties either aromatic hybrid or inbred, appropriate agronomic practices needs to be developed. Among these practices, application of nitrogen is the important factor to achieve higher yield from different rice varieties (Singh *et al.* 2004). It is an established fact that higher amounts of major nutrients, especially nitrogen, are required to exploit the full yield potential of high-yielding rice cultivars. Hybrids of any crop in general require higher doses of nitrogen. Meena et al. (2003) recorded the highest grain yield of rice hybrid with the application 200 kg N/ha. However, the information on nitrogen requirement and neem bitter-coated urea for optimum yield of newly-released aromatic hybrid ('PRH 10') and an aromatic high yielding variety ('Pusa 1121') is limited. Thus present study was carried out to find out the effect of modified urea products and nitrogen levels on growth, yield attributes and yield of an aromatic hybrid and a high yielding aromatic rice variety under transplanted condition.

MATERIALS AND METHODS

Field experiment was carried out on the experimental farm of the Indian Agricultural Research Institute, New Delhi (28o38'N latitude, 77o11'E longitude) during rainy season (June to October) of 2003. The experimental plot was sandy loam with pH 7.5 (soil to solution ratio 1:2.5), organic C 0.53%, total Kjeldahl N 0.05%, available P 18.5 kg ha-1 and available K 247.0 kg ha-1 in 0-20 cm soil (Prasad, 1998). The experiment was laid out in factorial randomized block design (FRBD) with 3 replications. There were in all 20 treatment combinations of varieties ('Pusa 1121' a high yielding aromatic variety; 'PRH 10' an aromatic hybrid recently developed at IARI); nitrogen levels (0, 50, 100 and 150 kg N/ha) and N sources studied beside prilled urea (PU) were neem bitter-coated urea, (NBCU 2%) and Pusa neem golden urea (PNGU), an urea neem-oil adduct was prepared by the process of crystallization from an oil and water emulsion containing urea. The coral shaped golden yellow adducts analysed 35% N as urea and 10% neem-oil. The experimental field was prepared by ploughing with a mouldboard plough and puddling twice in the first week of July and plots were made. Before the final puddling a uniform dose of 24 kg P/ha as single super phosphate 24 kg K/ha as muriate of potash and 5 kg zinc/ha as zinc sulphate was applied to the entire field. The whole quantity of nitrogenous fertilizer as per treatment was applied at one time i.e. 10 days after transplanting of rice seedlings. Twenty-five-day old seedlings keeping 1-2 per hill were transplanted at 20 cm x 10 cm spacing on 10th July 2003. The rice field was always kept in sub-merged conditions for whole crop growing period except 10 days before harvesting. The other packages of practices were followed as per the recommendations. Biometrics observations viz. plant height (cm), tillers/hill and dry matter accumulation (g/hill) were recorded at 30, 60 DAT and at harvest. Before harvesting of the crop yield attributes viz. number of panicles/m^2, panicle length (cm), panicle weight (g), filled grains/panicle and 1,000-grain weight (g) of rice were recorded. The crop was harvested in the last week of October and sun-dried for 4 days in the field and then total biomass yield was recorded. After threshing, cleaning and drying the grain yield was recorded. Straw yield was obtained by subtracting grain yield from total biomass yields and yields were expressed in t/ha. All the data recorded during experimentation were subjected to statistical analysis by applying the technique of analysis of variance and the significance was tested by 'F' test. Least significance difference (LSD) values at 5% level of significance were worked out for each character (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Growth characters

'Pusa 1121' had significantly taller plants than 'PRH 10' at harvest, probably due to the fact that the former variety had higher genetic rooting capacity (Table 1). Each successive increased in the level of N application increased the plant height significantly. The highest plant height was recorded with 150 kg N/ha and minimum with no N (control). This may be attributed to rapid elongation and multiplication of cells in the presence of the large amount of N. Neem bitter-coated urea (NBCU) and Pusa neem golden urea (PNGU) produced taller plants as compared to prilled urea (PU). Application of modified urea fertilizers, *viz.*, neem-coated urea and neem-oil emulsion-coated urea, irrespective of their concentrations had beneficial effect on plant height (Shivay *et al.*, 2001). 'PRH 10' produced significantly more tillers/hill as compared to the 'Pusa 1121'. Successive increase in N levels increased the number of total tillers/hill. Tillering is associated with the nutritional condition of the mother culm which supplies carbohydrate and other nutrients to developing tillers in early stages. Application of neem bitter-coated proved better than prilled urea and Pusa neem golden urea in respect to tillers/hill. It appears that NBCU regulated the N supply to crop better than PU. Results indicate that irrespective of growth stages, aromatic hybrid 'PRH 10' had more leaf area index than aromatic high yielding 'Pusa 1121'

Table 1. Effect of rice varieties, N levels and sources on growth attributes of rice

Treatment	Plant height at harvest (cm)	Tillers /hill at harvest	LAI*			Dry matter accumulation (g/hill)		
			30 DAT**	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
Varieties								
'PRH 10'	108.1	12.9	4.41	7.30	5.01	3.59	20.58	34.48
'Pusa 1121'	117.1	7.4	3.21	6.00	4.15	2.71	16.13	32.57
C.D. (P=0.05)	2.5	0.6	0.11	0.21	0.13	0.05	0.39	0.71
N levels (kg/ha)								
0	100.8	8.1	1.55	3.85	2.80	2.36	11.50	29.60
50	109.6	9.2	3.38	6.05	4.21	3.04	17.39	32.79
100	112.8	10.1	3.85	6.71	4.60	3.16	18.50	33.68
150	115.3	10.4	4.20	7.20	4.93	3.25	19.17	34.11
C.D. (P=0.05) (Control vs. rest)	8.0	1.9	0.38	0.68	0.42	0.16	1.29	2.32
C.D. (P=0.05) (between levels)	3.0	0.7	0.14	0.25	0.16	0.06	0.48	0.87
N Sources								
Prilled urea	110.3	9.3	4.83	5.10	3.60	3.68	14.90	31.95
Neem bitter-coated urea	113.5	10.5	3.88	6.68	4.58	2.96	18.42	33.71
Pusa neem golden urea	113.9	9.9	2.72	8.18	5.56	2.81	21.74	31.92
C.D. (P=0.05)	3.0	0.7	0.14	0.25	0.16	0.06	0.48	0.87

LAI*, Leaf area index; DAT**, Days after transplanting

due to its broad leaf characteristics. In case of both cultivars leaf area index increased up to 60 DAT and thereafter decreased as plant reached to maturity. Nitrogen application significantly increased the leaf area index with each successive increase in the N level up to 150 kg N/ha at all stages. Sources of N had shown a significant difference in LAI, i.e. initially 30 DAT, PU proved better than NBCU and PNGU; however, NBCU and PNGU produced significantly higher values of LAI than PU at 60 and 90 DAT. At all the growth stages studied, the aromatic hybrid 'PRH 10' produced significantly higher dry matter accumulation than a high yielding aromatic 'Pusa 1121'. The highest dry matter accumulation was recorded at harvest with the application of 150 kg N/ha being on par with 100 kg N/ha but significantly superior to 50 kg N/ha. As regard sources of N, modified N sources performed better at later stages of growth. NBCU and PNGU produced significantly more dry matter accumulation than PU at 30, 60 DAT and at harvest. But initially, at 30 DAT the application of PU performed better than NBCU and PNGU with respect to dry matter accumulation.

Yield attributes

Results indicate that an aromatic hybrid 'PRH 10' produced significantly more panicles/ m2 than 'Pusa 1121' and the percentage increase was about 16.6 (Table 2). The panicle density increased significantly ($P<0.05$) with each successive levels of N up to 100 kg/ha, but further increase in level of N to 150 kg/ha could not show significant increase in panicle density. Shivay *et al.* (2001) have also reported an increase in number of productive tillers/m^2 with increasing levels of fertilizer N. The sources of N affected number of panicles/m^2 significantly. NBCU and PNGU maintained panicle producing superiority over PU. Significant increases in number of panicles/m^2 due to application of different N sources conform to the finding of Kumar and Prasad (2004) and Shivay et al. (2001). Two cultivars under study also differed significantly with respect to panicle weight and length. Significantly higher panicle weight and length were recorded with an aromatic hybrid 'PRH 10' as compared to an aromatic high yielding variety 'Pusa 1121'. Panicle weight and length also increased significantly with each increase in the level of N dose up to 100 kg N/ha and it remained statistically on par with 150 kg N/ha. Positive effect of N on panicle weight and length has also been reported by Shivay (2007). Sources of N also significantly influenced the weight and length of panicle. The significantly higher values of panicle weight and length were recorded with Pusa neem golden urea and neem bitter-coated urea compared to prilled urea. Aromatic hybrid 'PRH 10' produced significantly more filled grains/panicle than 'Pusa 1121' and the percentage increase was 9.4. Increasing levels of N significantly increased the filled grains/panicle, however significant increase was recorded only up to 100 kg N/ha. Different sources of N affected the filled grains/panicle significantly. Highest values of filled grains were obtained with PNGU, being significantly greater to the other two sources (NBCU and PU). The similar results were also recorded with 1,000 grain weight of rice.

Grain yield, straw yield and harvest index

Aromatic hybrid 'PRH 10' was recorded significantly superiority over 'Pusa 1121' in respect of grain yield (Table 2). The difference in grain yield was mainly due to higher values of growth and yield attributes of 'PRH 10' viz., dry matter accumulation, LAI, panicles/m2, panicle length, filled grains/panicle and 1,000-grain weight as compared to 'Pusa 1121'. There was a significant increase in grain yield of rice with each successive increment in the levels of N only up to 100 kg N/ha, whereas the highest grain yield being obtained with 150 kg N/ha. Among N sources, PNGU recorded the highest grain yield, being significantly greater to NBCU and PU. Probably, the significant increase in growth and yield attributes with PNGU and NBCU over PU has caused a significant increase in grain yield by the former two N sources. Also, the improved nutrient uptake and utilization can be assigned as a reason for increased grain yield

Table 2. Effect rice varieties, N levels and sources on yield attributes, grain and straw yields and harvest index of rice

Treatment	Yield attributes					Yields (t/ha)		Harvest index (%)
	Panicles /m^2	Panicle weight (g)	Panicle length (cm)	Filled grains/ panicle	1,000 grain weight (g)	Grain	Straw	
Varieties								
'PRH 10'	267.2	2.12	28.33	119.1	21.11	6.16	10.00	38.17
'Pusa 1121'	229.1	1.59	27.30	108.9	20.05	3.60	7.60	32.17
C.D. (P=0.05)	5.81	0.03	0.60	3.30	0.47	1.55	2.00	0.82
N levels (kg/ha)								
0	200.0	1.12	25.10	95.0	19.25	3.47	7.85	30.64
50	241.5	1.80	26.43	108.5	19.65	4.50	8.50	34.65
100	250.3	1.87	28.26	115.8	20.96	4.98	8.93	35.81
150	252.7	1.90	28.73	118.7	21.03	5.16	9.02	36.40
C.D. (P=0.05) (Control vs. rest)	18.19	0.12	1.94	10.94	11.35	0.50	0.64	2.42
C.D. (P=0.05) (between levels)	6.87	0.04	0.73	4.13	0.57	0.19	0.24	0.97
N Sources								
Prilled urea	237.0	1.77	27.77	105.0	20.00	4.51	8.76	33.95
Neem bitter-coated urea	250.2	1.85	28.05	115.2	20.61	4.94	8.85	35.79
Pusa neem golden urea	257.3	1.94	28.11	121.8	21.13	5.20	8.80	37.13
C.D. (P=0.05)	6.87	0.04	0.73	4.13	0.57	0.19	NS	1.72

in PNGU and NBCU over PU. It also appears that modified urea materials were able to maintain the N supply sufficiently for a longer period of time as compared to PU, where the losses of N are expected to be higher. Aromatic hybrid 'PRH 10' produced significantly more straw yield over 'Pusa 1121'. Since the aromatic hybrid 'PRH 10' recorded significantly higher amount of dry matter (g/hill) compared to 'Pusa 1121' at harvest, which subsequently resulted in significantly higher straw yield of former variety in comparison to the latter. There was a significant increase in straw yield of rice due to each successive increment of N only up to 100 kg N/ha, whereas, the highest straw yield was recorded with 150 kg N/ha. Sources of N did not differ significantly in respect of straw yield. Aromatic hybrid 'PRH 10' gave significantly higher harvest index than the high yielding aromatic rice variety 'Pusa 1121'. There was an increase in harvest index with an increase in the level of N only up to 100 kg N/ha however, this level remained statistically on par with 150 kg N/ha. The sources of N had significant effect on harvest index. The significantly highest harvest index was recorded with PNGU compared to NBCU and PU.

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EFFECT OF ORGANIC WASTES AND NPK LEVELS ON THE NUTRIENT UPTAKE AND YIELD OF GROUNDNUT IN COASTAL SANDY SOIL

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ABSTRACT

An experiment was conducted at a farmers' field in sandy soil to study the effect of organics and NPK levels on the nutrient uptake and yield of groundnut. The soil (0-15 cm) had the following characteristics *viz.*, organic carbon- 0.37%, pH - 8.54, EC- 1.51 dS m^{-1}, available alkaline $KMnO_4$-N 114.28 kg ha^{-1}, Olsen P- 7.21 kg ha^{-1} and NH4OAC-K 124.74 kg ha^{-1}. Four levels of NPK *viz.*, no NPK, NPK (100%), NPK (125%) and NPK (150%) were used as treatments in main plots. Different sources of organics viz., control, composted coir pith (CCP) @ 12.5 t ha^{-1} and pressmud (PM) @ 12.5 t ha^{-1} were used as treatments in subplots. The treatments were replicated thrice in a Factorial Randomized Block Design (FRBD). The test crop was groundnut var. VRI 2. The experimental results indicated that 150% NPK level among the inorganics and composted coirpith @ 12.5 t ha^{-1} was significantly superior in increasing the uptake of nutrients by groundnut. This treatment combination also proved most efficient in increasing the yield of groundnut by recording 2196 and 2930 kg ha^{-1} of pod and haulm yield.

Key words : Groundnut, organic wastes, coastal soil.

Organic wastes have been successfully used in enhancing the productivity and fertility of soil and in maximizing yield of crops, as they have profound effect in supplying various nutrients and by rendering them in more available form in soil (Nagarajan *et al.*, 1986; Singh *et al.*, 1990).

The sandy soil, constitutes dominant type of soil in coastal regions. It is well known that this soil exhibit very poor physical property and nutrient availability. The fertilizers even when applied are prone to leaching losses. Hence in these soil, it is essential to study the additional nutrient requirement of crops and also to increase the efficiencies of applied nutrients. In the context, the organics play a significant role. Hence an attempted was made in the present study with integration of organics and increased levels of inorganics on groundnut yield and nutrient uptake.

MATERIALS AND METHODS

A field experiment was conducted at farmers field in Ponnanthittu village near Chidambaram during 2006. The soil (0-15 cm) had the following characteristics *viz.*, organic carbon- 0.37%, pH - 8.54, EC- 1.51 dS m^{-1}, available alkaline $KMnO_4$-N 114.28 kg/ha, Olsen P- 7.21 kg/ha and NH4OAC-K 124.74 kg/ha. Four levels of NPK *viz.*, No NPK, NPK (100%), NPK (125%) and NPK (150%) were used as treatments in main plots. Different sources of organics *viz.*, control, composted coir pith (CCP) @ 12.5 t/ha and pressmud (PM) @ 12.5 t/ha were used as treatments in subplots. The treatments were replicated thrice in a factorial randomised block design (FRBD). The test crop was groundnut var. VRI 2. N (17 kg N/ha), P (34 kg P_2O_5/ha) and K (54 kg K_2O/ha) were applied through urea, single super phosphate and muriate of potash, respectively. Half of the N and entire P and K were applied as basal and remaining half N was applied in two splits at flowering and peg formation stage. Organics as per the requirement of various treatments were applied. Pod and haulm yield at maturity stage were recorded. The pod and haulm samples were collected at harvest, dried in oven at 70°C, powdered and diacid extract was prepared. The concentrations of nutrients *viz.*, N, P, K Ca, Mg, S and micronutrients namely Fe, Zn, and B. were estimated using the standard procedure as outlined by Jackson (1973) and uptake were calculated

RESULTS AND DISCUSSION

Growth and yield

The results clearly revealed that, plant height, no. of branches/plant, dry mater production and yield were significantly influenced by application of CCP and PM. The combined application of composted coirpith @ 12.5 t/ha and 150% NPK recorded the highest growth characters like plant height, no of branches plant and dry mater production.

With regard to yield (Table 1) also the highest pod and haulm yield of2196 and 2930 kg/ha respectively was registered with the treatment 150% NPK and composted coirpith @ 12.5 t/ha. This treatment was followed by 150% NPK and pressmud application, which recorded 2019 kg/ha of pod and 2775 kg ha^{-1} of haulm yield.

The increased growth characters with organics and NPK might be due to the improved soil properties and microbial activity as reported by (Trivedi, 2003). The reduced pH and EC and increased organic carbon resulted in increased nutrient availability in soil which made the plant to absorb more nutrients and increased the yield of groundnut. The reports of Nagarajan e*t al.* (1986) and Solarnalai *et al.* (2001) confirm the present findings.

Major nutrient uptake

Sandy soils exhibit very low nutrient status because of low organic status, microbes and poor physical properties. In the present study, the influence of organics in enhancing nutrition of groundnut with respect to major nutrient uptake was well evidenced. Both the sources of organics *viz.* CCP and PM proved their usefulness in increasing the uptake of major nutrients. However, the effect of CCP was much pronounced. Among the inorganic levels, 150 per cent NPK. The highest uptake of NPK by pod and haulm was recorded by the treatment 150 per cent NPK with CCP application. The addition of organics along with inorganic fertilizers enhanced the uptake of nutrients through increased availability of these nutrients and improved soil conditions as created by addition of organics (Kachot *et al.*, 2001). Application of organic manures helped in solubilization of native nutrients due to chelating effect of complex immediate organic molecules as produced during their decomposition and mobilization of different nutrients towards plant systems and accumulates in crops (Dosani *et al.*, 1999).

Secondary nutrients uptake

In the case of secondary nutrients uptake, application of PM increased the Ca uptake and the application of composted coirpith recorded the highest Mg and S uptake. The combined application of CCP @ 12.5 t/ha and 150 per cent NPK registered the highest Mg uptake by pod and haulm and S uptake by pod and haulm, respectively. The organics PM along with 150% NPK registered the highest Ca uptake by pod and haulm. The increased uptake of secondary nutrients with organics might be due to their effect on improving the physico-chemical properties. The increased Ca uptake with PM could be attributed to the highest content of Ca in PM. This is in accordance with the earlier findings of Solamalai *et al.* (2001) and Trivedi, (2003).

Micronutrients uptake

In sustaining the groundnut yield, micronutrients play a significant role and especially the role of Zn, Fe and B is well established. In the present study, all the organics evaluated along with different levels of NPK fertilizers significantly increased the micronutrients uptake by groundnut.

Among the sources of organics, application of CCP registered the highest micronutrients uptake followed by PM application. The combined application of 150 per cent NPK and CCP @ 12.5 t/ha recorded the highest Zn uptake of 248.17 and 171.41 g/ha, Fe uptake of 502.44 and 757.55 g/ha and B uptake of 3.037 and 5.801 g/ha by pod and haulm, respectively. This treatment was followed by the combined

Table 1. Effect of organics and varying NPK levels on the growth character, yield and uptake of N, P and K

Treatment	Plant height (cm)	No. of branches/ plant	Dry matter production (kg/ha)	No. of pods/ plant	Yield (kg/ha)		N-uptake		P-uptake		K-uptake	
					Pod	Haulm	Pod	Haulm	Pod	Haulm	Pod	Haulm
A_1B_1	22.45	4.07	3142	12.45	1130	1912	21.24	20.46	2.27	3.75	6.78	22.94
A_1B_2	35.66	5.47	3763	20.13	1440	2223	32.83	29.12	3.86	5.78	11.52	34.01
A_1B_1	31.86	4.95	3614	18.08	1413	2101	28.40	28.57	3.67	7.21	10.88	31.09
A_2B_1	30.21	7.12	3923	21.78	1568	2255	34.97	29.77	5.03	6.07	12.86	36.08
A_2B_2	48.35	8.87	4545	27.53	1896	2549	49.11	38.24	6.45	8.13	18.96	45.88
A_2B_3	38.27	8.52	4227	25.28	1738	2389	37.89	35.36	5.72	7.17	15.64	4.85
A_3B_1	40.27	8.15	4278	25.18	1728	2450	40.44	36.51	6.22	7.50	16.07	43.86
A_3B_2	51.02	10.45	4879	30.83	20.1	2748	56.87	45.62	7.86	9.54	22.54	52.21
A_3B_3	45.86	9.65	4596	28.58	1906	2590	48.90	40.66	7.01	8.44	19.44	47.66
A_4B_1	46.27	8.67	4643	26.78	1921	2622	48.22	41.95	7.32	8.65	19.02	48.77
A_4B_2	53.26	10.83	5226	32.43	2196	2930	67.64	52.44	9.03	10.87	25.91	58.01
A_4B_3	50.81	10.21	4894	30.20	2019	2775	58.69	46.34	7.83	9.66	22.06	53.56
SEm±	0.97	0.11	124.9	0.11	50.1	81.8	1.69	1.15	0.75	0.34	1.01	1.84
CD at 5%	2.01	0.22	258.6	0.38	103.7	169.2	3.50	2.40	1.51	0.70	2.00	3.80
A	0.37	0.77	0.05	0.10	79.87	165.34	0.09	0.19	27.68	57.30	60.15	124.52
B	0.62	1.30	0.06	0.13	85.27	176.51	0.11	0.22	34.98	72.41	63.59	131.64
AxB	0.97	2.01	0.11	0.22	124.90	258.56	0.18	0.38	50.10	103.71	81.75	169.23

A_1-absolute control; A_2-100% NPK; A_3-125% NPK and A_4-150% NPK
B_1-control; B_2-composed coir pith @ 12.5 t/ha and B_3-pressumed @ 125 t/ha

Table 2. Effect of organics and varying NPK levels on the secondary and micro-nutrients uptake in groundnut

Treatment	Ca-uptake (kg/ha)		Mg-uptake (kg/ha)		S-uptake (kg/ha)		Zn-uptake (g/ha)		Fe uptake (g/ha)		B uptake (g/ha)	
	Pod	Haulm	Pod	Haulm	Pod	Haulm	Pod	Haulm	Pod	Haulm	Pod	Haulm
A_1B_1	2.37	7.65	1.02	4.02	0.34	1.14	100.61	55.93	185.90	286.70	0.909	2.294
A_1B_2	5.47	21.56	2.59	8.00	1.73	3.78	141.69	89.54	270.37	414.68	1.447	3.430
A_1B_3	5.93	27.73	2.12	5.88	0.99	2.31	132.69	77.30	255.71	352.21	1.373	3.109
A_2B_1	4.39	18.94	3.76	8.12	2.04	3.38	156.49	99.24	296.43	428.04	1.610	3.613
A_2B_2	8.34	32.63	6.07	12.24	3.98	6.37	198.76	132.65	391.07	563.92	2.281	4.619
A_2B_3	8.86	37.03	4.69	9.79	2.95	4.78	178.48	117.59	345.55	476.10	1.924	4.088
A_3B_1	5.53	23.28	5.01	10.29	3.11	5.15	176.84	114.76	346.90	507.76	1.965	4.393
A_3B_2	9.95	37.65	8.12	15.39	5.48	8.52	224.44	154.27	448.71	669.93	2.646	5.249
A_3B_3	10.48	42.22	6.86	12.95	4.38	6.73	203.96	137.50	404.30	580.39	2.339	4.848
A_4B_1	6.92	26.74	6.34	12.59	4.23	6.82	201.15	129.19	397.55	573.96	2.299	4.851
A_4B_2	11.42	42.49	9.88	18.17	6.81	10.26	248.17	171.41	502.44	757.55	3.037	5.081
A_4B_3	11.71	47.18	8.28	15.82	5.45	8.60	220.84	154.62	443.82	667.75	2.619	5.
SEm±	0.36	0.60	0.51	0.99	0.49	0.60	6.50	0.60	0.49	0.60	0.034	0.042
CD at 5%	0.75	1.25	1.05	2.06	1.01	1.25	13.52	1.25	1.01	1.25	0.070	0.086

A_1-absolute control; A_2-100% NPK; A_3-125% NPK and A_4-150% NPK
B_1-control; B_2-composed coir pith @ 12.5 t/ha and B_3-pressumed @ 125 t/ha

application of 150 per cent NPK and PM application. The chelation properties of organics might have prevented precipitation and fixation of micronutrients, kept them in available form that made the plant to absorb these nutrients in higher amounts (Talashilkar *et al.*, 1997).

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PRODUCTION POTENTIAL OF SUNFLOWER ALEY CROPPED WITH NEEM AND MELIA UNDER DRY LAND CONDITION

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ABSTRACT

A field experiment was conducted during *kharif* season of 2004 and 2005 at Hyderabad, to evaluate the performance of sunflower in alley cropping system with neem and melia trees in red loamy soils of dry lands. It was observed that sole cropped sunflower gave significantly higher seed yield than that of intercropped sunflower both n pollarded neem and melia, because of competitive effect of trees. However sunflower when intercropped with pollarded neem and melia gave markedly and substantially higher growth and net returns resulting in increased B:C ratio during both the years of study than sole cropping of sunflower due to additional advantage of value added products from neem and melia trees mainly in the form of poles.

Key words : Sunflower, alley cropping system, neem, melia.

One of the need based alternate land use systems replacing the traditional farming system is a tree based cropping system i.e., agro-forestry The success of any agro-forestry system depends on the tree, crop and their ability to tap the resource pools of light, water and mineral nutrients. Generally trees when grown in age advancement tend to suppress the growth and yield of associated crops because of canopy spread. This suppression is attributed to shading or competition among the roots for water and nutrients. To regularize the shade in agro-forestry system, trees are usually pruned during the cropping period to avoid the competition for light his agro-forestry practice is called alley cropping. Alley cropping as one of the agro-forestry practices would produce nutrients when cut vegetative matter is incorporated as green manure or spread on soil surface and help to reduce negative tree crop interaction and augment total production of agro forestry system (Kang *et al.*, 1985). Neem and melia trees are preferred as components in alley cropping system of agro-forestry as these are important, straight. last growing. versatile and multipurpose tree species. Sunflower being an important oil seed crop is said to he more suitable intercropping with trees under dry land situations especially when trees are kept pruned to avoid light competition.

MATERIALS AND METHODS

A field experiment was conducted during *kharf* seasons of 2004 and 2005 at Student Farm College of Agriculture, Rajendranagar, Hyderabad to evaluate the performance of sunflower in alley cropping system, with neem and melia trees under dryland situations. The site of the experiment was red loamy soil. The experimental site under neem and melia plantations was medium in organic carbon, available P_2O_5 and K_2O and low in available N where as the soil in open areas was low in organic carbon and available P_2O_5 and K_2O. The site was under eight years old neem planted during 1997 and nine years old melia planted during 1996 which were spaced at 4m x 3m and 6m x 2m, respectively.

The treatments comprised of three cropping systems *viz.*, intercropping of sunflower in pollarded neem (ICPN), intercropping of sunflower in pollarded melia (ICPM) and sole cropping of sunflower (SC) as main plots and six sub plot treatments with organic and inorganic sources of nitrogen replicated thrice in split plot design. The recommended dose of NPK was 60:60: 30 kg/ha.

The required quantities of FYM for treatmental plots were calculated @ 5 t/ha while green leaf manuring (GLM) was obtained by pruning neem and melia branches and applied @ 5 t/ha. Both FYM and GLM were incorporated in the experimental plots 15 days before sowing of sunflower crop in all the three cropping systems. The neem and melia leaves were collected and used for mulching by spreading the leaves in the plots 15 days before sowing of the seed. A uniform dose of 60 kg P_2O_5 and 30 kg K_2O/ha were applied through single super phosphate and murate of potash, respectively as basal dose to all the experimental plots. Where as the requisite amount of nitrogen was applied through urea in two splits based on recommended dose @ 60 kg/ha.

While calculating the monetary returns of the intercropping system, the estimated returns from the tree component (neem and melia) were added to the returns obtained from the intercropped sunflower (Table 1).

RESULTS AND DISCUSSION

Effect of cropping systems

Seed yield of sunflower was significantly influenced by cropping systems during both the years of study. Sole cropped sunflower gave significantly higher seed yield than that of intercropped sunflower both in pollarded neem as well as melia. The reduction in the seed yield of intercropped sunflower under pollarded neem and melia trees was 13.4% and 20.1% (2004) and 17.1% and 20.48% (2005), respectively over the seed yield of sole sunflower (Table 1). Though intercropping in pollarded neem recorded significantly more seed yield than intercropping in pollarded melia in the year 2004, but the seed yield was found more or less same in both the intercropping situation in the year 2005. Though the trees of neem and melia were pollarded to avoid competition for light but it appears to be the competitive effect of trees because of fast growing nature for moisture and nutrients which might have resulted in reduction in seed yield of sunflower when inter cropped. Declined seed yield of sunflower with the association of melia and neem trees were observed during the studies carried out by Okori *et al.*, (1994), Sarada Dcvi (1999) and Panneer Selvem (2003). Pooled analysis of seed yield showed the same trend with cropping systems. Thus the average seed yield was found increased to the maximum extent in sole cropped sunflower hen compared to intercropping sunflower.

Economics

Economic evaluation of different cropping systems in terms of monetary returs showed that sunflower when intercropped with pollarded neem and melia gave markedly and substantially higher gross and net returns resulting in increased B:C ratio during both the years of study. The increase in total gross and net monetary returns from the system (tree and crop) under intercropping of sunflower in pollarded neem and melia trees was by 35.75% and 32.96% in 2004 and by 28.15% and 27.23% in 2005 over sole cropping of sunflower, respectively (Table 1).

The substantial increase in monetary returns in intercropping of sunflower in pollarded trees of neem and melia was mainly due to additional advantage of value added products from neem and melia trees mainly in the form of poles . It was evident from the data that inclusion of a woody perennial in the cropping system helped in pros iding additional income through value added products (poles) resulting in higher monetary returns in addition to returns from sunflower crop. Many workers reported simiilar advantages in the tree-crop combination studies (Mittal and Singh. Bheemaiah *et al.*, 1996) B:C ratio was substantially increased under intercropping of sunflower in association with neem or melia trees when compared to sole cropping of sunflower. It was clearly evident from the results that monetary returns from the tree component resulted in considerable hike in profit per rupee invested under tree based cropping system in comparison with that of sole crop specially under dry land situations. The same trend was seen in average monetary returns of two years study with the cropping systems.

Table 1. Seed yield and monetary returns as influenced by cropping and integrated nutrient management practices (INM)

Treatment	Seed yield (kg/ha)			Gross returns			Net returns			B : C ratio		
	2004	2005	Pooled	2004	2005	Pooled	2004	2005	Pooled	2004	2005	Pooled
Cropping system												
ICPN	628	597	612.5	13386	12047	12716.5	6594	5357	5975.5	0.96	0.80	0.88
ICPM	580	574	5770	12829	11.895	12362.0	60.37	5305	5671.0	0.88	0.80	0.84
Sole	726	721	723.5	8600	8656	8628.0	2786	2986	2886.0	0.47	0.52	0.49
SEm±	10.0	9.48	4.50	--	--	--	--	--	--	--	--	--
CD at 5%	3.9	27	9.39	--	--	--	--	--	--	--	--	--
INM practies												
FYM (5 t/ha) + 50% RD of NPK	551	490	520.5	10496	9809	10152.5	4360	3702	4031	0.69	0.59	0.64
GLM with neem+50% RD of NPK	531	440	485.5	10254	9493	19747	4317	3618	3967.5	0.71	0.60	0.655
GLM with Melia (5t/ha) + 50 RD of NPK	520	486	503.0	10134	9577	9855.5	4197	3637	3917	0.69	0.60	0.64
Mulching with neem leaves + RD of NPK	772	757	764.5	13108	12437	12772.5	6062	5489	5775.5	0.84	0.77	0.80
Mulching with melia leaves + RD of NPK	756	734	745.0	12925	12285	12605	5879	5353	5616	0.82	0.76	0.79
RD of NPK	738	615	676.5	12711	11589	12150	6020	4986	5503	0.88	0.74	0.81
SEm±	16.0	22.9	7.0	--	--	--	--	--	--	--	--	--
CD at 5%	46.0	51.5	16.27	--	--	--	--	---	--	--	--	--

ICPN - Interecropping of sunflower in pollarded neem
ICPM - Intercropping of sunflower in pollarded melia
Sole - Sole cropping of sunflower
RD - Recommended dise
GLM - Green leaf manure

Effect of integrated nutrient management (INM) practices

Among the INM practices, the mulching with neem leaves + recommended dose of NPK, mulching with melia leaves + recommended dose of NPK and recommended dose of NPK, produced significantly higher seed yield than 50% of recommended dose of NPK with combination of FYM or green leaf manuring with neem or melia during both the years of study. The maximum seed yield was obtained with recommended dose of NPK with mulching practices either by neem leaves or melia leaves. The reason for more yields under mulching practices could be due to higher conservation of moisture in plots coupled with suppression of weed growth and reduction in soil temperature. These results are in conformity with the findings of Arnold Budelman (1989) and Kayande *et al.* (1995). Incorporation of FYM as well as of neem and melia leaves as green manure with 50% recommended dose of NPK could not compensate with the seed yields obtained by recommended dose of NPK. Mostly slow decomposition rate due to higher fiber content in neem and melia leaves might be one of reasons for not synchronizing the release of nutrients with the growth of sunflower. Similar results were reported by Mafongova *et al.* (1998) and Seneviratine *et al.* (1998). There was no change in influence of INM practices on seed yield with the average values of two ears when compared to that of individual years.

Integrated Nutrient Management practices also influenced the monetary returns markedly. Higher gross and net returns were obtained with mulching either with neem or melia leaves with recommended dose of NPK followed by only recommended dose of NPK. Whereas 50% recommended dose of N PK either with FYM or green leaf manuring did not prove to be effective in enhancement of monetary returns though the cost of chemical fertilizers was reduced. Similar trend was observed in influencing B:C ratio. The maximum benefit with one rupee invested was obtained when mulching practice as adopted with recommended dose of NPK. The improved monetary returns under mulching practices were mainly attributed to higher seed yield due to favourable soil characteristics. Similar results were reported by Mittal and Singh (1992).

The results of the experiment apparently indicated that though the yield of sunflower was found better under sole cropping, but the economics in terms of monetary returns were found higher in alley cropping system with neem and melia leaves as a mulch *in situ* helped to improve the yield and returns from the tree based cropping system when the trees were pollarded to avoid the shade effect. The findings of the present study are very much useful for dryland farmers who are solely depending on traditional agriculture which is uncertain and risky.

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MANAGEMENT OF PEANUT BUD NECROSIS DISEASE IN GROUNDNUT THROUGH TOLERANT VARIETIES

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ABSTRACT

Five groundnut varieties with different levels of resistance to PBND were experimented for three rainy and two post rainy seasons to analyse their effect on management of PBND. The results revealed that final PBND incidence, apparent infection rate. Area under disease progress curves (AUDPC) value were consistent with the respective variety. Further, 'TG-26' out yielded other varieties in terms of pod yield (1,112, 1,943 kg/ha in rainy and post rainy season respectively) with less apparent infection rate (0.003494) low PBND % (17.76) low AUDPC value (741) indicating its tolerance and better performance.

Key words : Groundnut, peanut bud necrosis disease, peanut bud necrosis virus, management, tolerant varieties.

Groundnut (*Arachis hypogaea* L.), a principal oilseed crop of the world is cultivated on 20.4 million hectares. In India, it is grown on 8.5 million hectares contributing to 55 per cent of the total oilseed production and rank's first in the world both in total area and production. However, the productivity is 800-900 kg/ha, which is below the global average production of 1,000 kg/ha. Biotic constraints are largely responsible for the loss of yields. Among the fungal diseases, rust, early and late leaf spots are important. However, they can be effectively controlled by a combination of host plant resistance and judicial use of fungicides. The other major diseases are of virus etiology. Among them, peanut bud necrosis disease (PBND) is considered to be the most important one and it is known to cause severe crop losses. PBND was first reported from India by Reddy *et al.*, (1968) on groundnut. The causal agent of PBND was reported as tomato spotted wilt virus (TSWV) (Ghanekar *et al.*, 1979). The causal virus was subsequently identified as a distinct Topsovirus and named as peanut bud necrosis virus (PBNV) Reddy *et al.* (1992) and its distribution is reported to be restricted to Asia.

The PBNV is widely distributed in India. Bud necrosis is one of the most devastating diseases affecting groundnut and other crops such as tomato, watermelon, chilli, brinjal, greengram, blackgram, and soybeans. It occurs at high incidence in some areas in the states of Andhra Pradesh (AP), Gujarat, Karnataka, Maharashtra, Rajasthan, Tamil Nadu, and Western Uttar Pradesh. In India alone, the loss due to PBND in groundnut was estimated to be Rs. 270 crores (ICRISAT medium term plan 1994-98). Losses depend mainly on the level of incidence and severity of symptoms. If the infection occurs on young plants (<60 days), pod yield loss will be cent per cent (Rao *et al.*, 1984; Gopal and Upadhyaya, 1988). If infection occurs after the plants start to produce pods, losses are minimal.

Options for the management of plant virus diseases are adjustment of cultural practices, judicious use of chemicals for vectors and utilization of host plant resistance. In the absence of effective chemical control, research has to be done on cultural practices (Brown *et al.*, 1996) for the management which might be modified to reduce the impact of PBNV on groundnut. In the case of TSWV, cultural practicessuch as date of planting, plant density and intercropping with cereals have been shown to be effective for its management (Reddy, 1991). Epidemics of PBNV progress at slower rates on some groundnut cultivars, and host-plant resistance seems to be a promising method of disease management. In this direction management of PBND using varieties with different levels of resistance to PBNV were tested under epiphytotic field conditions for pod yield and tolerance to PBND and the results are reported here.

MATERIALS AND METHODS

Six groundnut varieties, two highly susceptible (JL 24 and K 134) and four field resistant ones (ICGS 11, TG 26, ICGV 86590 and ICGV 86031) were tested in three rainy and two post rainy seasons from 2000 to 2002 at Regional Agricultural Research Station (RARS), Jagtial (A.P.). Each variety was sown in four replications and each replication consisted of six rows of 5 m length with 40 cm between rows and 20 cm between plants. The genotypes were planted in randomized complete block design (RCBD). PBND incidence was recorded between 30 to 120, 35 to 142, 60 to 110, 45 to 142, 45 to 95 days after sowing (DAS) in 2000, 2000-01, 2001, 2001-02 and 2002 seasons, respectively. Infected plants were recorded by marking with coloured bamboo sticks as described below. AUDPC, D50%, PBND% and r values were calculated as described below. Pod yield, and shelling (%) were analysed statistically.

Marking PBND infected groundnut plants in the field

All PBND infected plants were marked with different coloured bamboo sticks utilizing an uniform colour for each set of recording. They were recorded at approximately 7 to 10 days interval starting from 30 DAS, until the crop attained maturity.

Area under disease progress curves (AUDPC)

To differentiate and select the best treatment/genotypes, the PBND incidence was quantified by using the following formulae and analyzed in RCBD (Nagarajan and Muralidharan, 1995).

$$A = \sum_{i-1}^{k} 1/2(S_i + S_{i-1})d$$

Where S_i = disease incidence at the end of the week i

k = the number of successive evaluations of disease

d = interval between two evaluations

Apparent rate of infection (r)

It was calculated by linear model ($Y = b + rt$, after transforming the disease incidence as proportion (0-1) of PBND infected plants (Nutter ,1997) untill otherwise mentioned.

Statistical analysis

The angular transformed cumulative per cent PBND incidence data, the original data of pod yield, shelling and AUDPC values were analysed in RCBD and factorial RCBD (whichever applied) by using the statistical software Genstat 5 release 3.2. Non-linear growth models of Logistic and Gompertz were fitted using regression commands of Genstat in the construction of temporal disease progress curves.

RESULTS AND DISCUSSSION

There was sufficient PBND disease pressure during all the five seasons for effective screening of genotypes against the disease. The disease pressure was 95.63, 49.4, 83.37, 40.33 and 44.41% PBND during 2000, 2001, 2002 rainy season 2000-01 and 2001-02 post-rainy season, respectively. During all the test seasons PBND % occurred first and high in susceptible check JL 24. Five genotypes, ICGV 86031, ICGV 86590, ICGS 11 (field resistant), TG 26 (new variety in the process of release) and K134 (newly released variety) were tested. In three rainy and two post-rainy seasons under high disease pressure. The final disease incidence, apparent infection rate and AUDPC value were consistent in all the seasons tested with respect to resistant level of the genotypes. This indicates the significance of genotypic effect on PBND incidence and AUDPC. The performance of all the field resistant genotypes with respect to yield and AUDPC were on par (Tables 1,2).

However, the apparent infection rate and PBND incidence, always less and pod yield (mean yield of 1112 kg/ha in rainy and 1943 kg/ha in post-rainy seasons) was higher in TG 26 indicating its better performance compared to other field resistant genotypes (Tables 1, 2). While the high yielding susceptible check JL 24 showed higher PBND incidence (95.63, 49.4, 83.37 in 2000, 2001, 2002 rainy seasons and 40.33, 44.41 in 200001 and 2001-02 post-rainy seasons, respectively), high infection rate (0.0124, 0.0098, 0.01165 during 2000, 2001, 2002 rainy seasons; 0.00364, 0.00487 in 2000-01. 2001-02 post-rainy seasons, respectively). Higher AUDPC value found to be attributed to lower pod yields (719 and 1398 kg/ha of mean pod yield in three rainy and two post-rainy seasons, respectively).

Growing field resistant varieties seems to be a promising method of disease management in general and particularly against viral diseases. PBND progress at slower rate on some groundnut cultivars was observed. The mechanism of resistance is not yet understood but it may be because of differential thrips preferences for groundnut cultivars.

Field resistant varieties effect on PBND suppression, revealed that the susceptible cv. JL 24 always had higher incidence, higher AUDPC and higher apparent infection rate compared to other varieties. TTG 26 was found promising in suppressing the PBND by slow progress of the disease, low final incidence, low AUDPC and significantly out yielded all the genotypes in rainy season except ICGV 86590. It was on par in yields with ICGS 11 and superior to rest of the varieties especially in post-rainy season. There are no reports on temporal disease progress curves (TDPC) of PBND in groundnut. Cuibreath *et al.* (1992 and 1994) studied the TDPC on TSWV at Georgia in groundnut cvs, Southern Runner, Georgia Browne and Florunner and reported that the final incidence and apparent infection rate were higher in Florunner than Southern Runner and Georgia Browne. The present studies also showed that the field resistant high yielding varieties significantly suppressed the PBND by slow progress of the disease. These results are supported by Arnin (1985) and Culbreath *et al.* (1992 and 1994). Amin (1985) also reported that there was lower infestation of thrips under field tests on field resistant 'R 33-1' than susceptible 'TMV 2'. Under laboratory, R 33-1 did not adversely affect the longevity and fecundity of F.schultzei . With these results he was of opinion that non-preference of thrips for cv. R 33-1, resulted in low incidence of TSWV. Therefore, these reports are in support of non-preference of thrips for cv. TG 26 which resulted in low incidence of PBND.

The studies indicate that final PBND incidence, apparent infection rate, AUDPC value were consistent with the respective genotype/variety. Further, TG-26 out yielded other genotypes in terms of pod yield (1112, 1943 kg/

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Table 1. Pod yields of six groundnut genotypes that showed different levels of PBND resistance during 3 rainy and 2 post rainy scasons, at RARS, Jagtial (A.P.) during 2000-2002

Genotype	Pod yield (kg/ha)						
	Rainy season				Post rainy season		
	2000	2001	2002	Pooled^a	2000-01	2001-02	Pooled^a
JL 24	733	829	774	779	1386	1409	1398
K 134	793	896	736	808	1493	1511	1502
ICGS 11	965	998	974	979	1890	1989	1940
TG-26	4429	1139	1068	1112	1913	1972	1943
ICGV 86590	1089	1164	1102	1118	1606	1584	1595
ICGV 86031	943	1020	953	972	1464	1579	1521
S (m ±)	66.4	68.40	61.9	–	85.9	100.6	–
LSD (=0.01)	100.00	103	63.52	52	129	152	90
CV%	6.98	6.92	6.36	6.54	5.29	6.01	5.4

a= In pooled analysis, genotypcs are significant LSD (P<0.001), CV (%) are presented above and years are not significant (P=0.05).

Table 2. PBND incidence, AUDPC and apparent infection rates for 6 groundnut genotyps that showed different levels of resistance to PBNV during 5 seasons (2000-2002) at RARS, Jagtial (AP).

genotypes	Final PBND (%)					AUDPC					Apparent infection rate[a]				
	Rainy season			Post rainy season		Rainy season			Post rainy season		Rainy season			Post rainy season	
	2000	2001	2002	2000-01	2001-02	2000	2001	2002	2000-01	2001-02	2000	2001	2002	2000-01	2001-02
JL 24	95.63 (9.83)	49.40 (7.09)	83.37 (9.18)	40.33 (6.39)	44.41 (6.74)	3674	1079	3448	2023	2553	0.0124	0.0098	0.01165	0.00364	0.00487
K 134	85.15 (9.28)	46.12 (6.84)	93.28 (9.71)	35.53 (6.04)	39.90 (6.39)	3110	918	3907	1944	2169	0.0114	0.00869	0.01281	0.0032	0.00443
ICGS 11	36.34 (6.11)	18.29 (4.65)	50.07 (7.17)	18.66 (4.43)	7.47 (2.90)	918	413	1893	893	434	0.0041	0.0013	0.0086	0.00158	0.00081
TG-26	13.54 (3.80)	12.83 (3.68)	34.32 (5.93)	13.18 (3.76)	14.93 (93.98)	540	454	1203	734	774	0.0061	0.0023	0.0062	0.00102	0.00185
ICGV 86590	26.77 (5.27)	9.91 (3.20)	27.53 (5.22)	11.30 (3.50)	9.23 (3.06)	723	161	945	539	471	0.0031	0.00175	0.00495	0.00098	0.00117
ICGV 86031	26.43 (5.23)	10.49 (3.35)	32.54 (5.77)	12.60 (3.67)	10.20 (3.34)	654	172	1106	482	459	0.00293	0.00199	0.0061	0.00109	0.00009
SE (m±)	(0.0762)	(0.2617)	(0.115)	(0.055	(0.084)	138.6	61.0	147.2	103.5	96.8					
LSD (P= 0.01)	(0.2128)	(0.2617)	(0.322)	(0.155)	(0.236)	417.7	183.8	443.7	311.8	291.8					
CV%	13.70	17.80	10.00	10.80	14.40	17.3	28.2	14.1	18.8	17.4					

a = Apparent infection rate estimated by linear equation, y = b + rt h in rainy and post-rainy seasons, respectively) with less apparent infection rate (0.0061, 0.0023, 0.0062 in 2000. 2001. 2002 rainy seasons; 0.00102, 0.00185, during 2000-01, 2001-02 post-rainy seasons, respectively), low PBND % (13.54, 12.83 and 34.32 during 2000, 2001. 2002 rainy seasons: 13.18. 14.93 during 2000-01 and 2001-02 post-rainy seasons, respectively) low AUDPC value (540, 454, 1203 during 2000, 2001. 2002 rainy seasons respectively; 734, 774 during 2000-01 and 2001-02 post-rainy seasons, respectively) along with less number of *T. palmi* population (6/30 leaves at 60 DAS, 7/30 leaves at 95 DAS, 8/30 leaves at 60 DAS during 2000, 2001, 2002 rainy season, respectively) indicating its better performance.

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EVALUATION OF BRINJAL (*SOLANUM MELONGENA* L.) GENOTYPES FOR HORTICULTURAL TRAITS UNDER HOT ARID ENVIRONMENT

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Abstract

Seventeen cultivars of brinjal were evaluated over two years under hot arid environment. The highest yield of 4.15 kg/plant was obtained from Pusa Uttam. The cultivar Pusa Ankur was earliest which took 42.33 days to first flower (DAS). Cultivar Arka Kusumakar expressed the maximum number of fruit (69.40 per plant) while cultivar Udaipur Local expressed the maximum weight (110 g). The cultivars IC-90984, Udaipur Local, Pusa Purple Cluster and Pusa Bhairav with moderately high yield of 3.53, 3.42, 3.33 and 3.25 kg/plant respectively, can be grown in addition to Pusa Uttam under hot arid environment.

Key words : Genotypes, evaluation, brinjal, horticultural traits.

Brinjal (*Solanum melongena* L.) is one of the most important vegetables grown in almost all parts of the country except higher altitude. It is very popular among the people of all social strata hence it is rightly called as vegetable of the masses (Choudhary and Kalda). Brinjal is adopted to a wide range of climatic conditions and has ability to tolerate the extremes of temperature and drought. Therefore, diverse cultivars collected from various sources were evaluated for horticultural traits and tested for yield potential to identify suitable types in brinjal for the cultivation under hot arid environment.

Materials and Methods

The experiment consisting of 17 cultivars of brinjal was laid out in a randomized block design with 3 replications at Central Institute of Arid Horticulture, Bikaner, Rajasthan during 2002-03 and 2003-04 as rainfed winter season crop. Four weeks old healthy seedlings of each cultivar were transplanted at a spacing of 75 x 60 cm in a plot of 4.5 x 3.6 m. Recommended package of practices were adopted to raise the crop successfully. Five plants were selected at random in each plot every year to record the observation on yield and its traits and were statistically analyzed as suggested by Panse and Sukhatme (Panse and Sukhatme, 1978).

Results and Discussion

Pooled analysis of variance carried out for all the characters revealed significant differences among genotype and environment that not only indicated the extent of diversity in growing conditions but also reflected the degree of genetic variability among the test material.

The mean performance of the cultivars over the years is presented in Table 1. The cultivar Pusa Uttam was at the top with yield of 4.15 kg/plant. The cultivar Pusa Bhairav produced the tallest plant and IC-112309 was at par while AHB-1 registered the shortest plant. Similarly, the plant spread was maximum in case IC-I 12358, other cultivars except Pusa Ankur, Arka Kesav, Pusa Purple Cluster, Pusa Upkar, Pusa Bhairav, Arka Kusumukar, IC-I12309 and Arka Sheel were at par while Pusa Purple Cluster registered the minimum plant spread. Wide variation for growth characters was also reported by Kumar *et al.* (1999) in *chilli*. Days to first flower (DAS) is envisaged as an index of earliness. The cultivar Pusa Ankur took 42.33 days for the days to first flower (DAS) and thus was the earliest one, while AHB-2 was the late cultivar conceding 65.33 days for the days to first flower (DAS). Highest fruit weight (110 g) was recorded in Udaipur Local.

Number of fruits per plant is the most

Table 1. Performance of brinjal cultivars/genotypes (Pooled mean of 2002-03 and 2003-04

Cultivars	Plant height (cm)	Plant spread (cm)	Days to first flower (DAS)	Weight of fruit (g)	Length of fruit (cm)	Girth of fruit (cm)	No. of fruits/ plant	Fruit yield (kg/plant)	Fruit shape	Fruit colour
Pusa Ankur	72.60	74.80	42.33	40.20	6.60	5.26	27.60	1.11	Oval round	Dark purple
Arka Nidhi	94.67	95.40	49.67	35.67	10.60	2.82	41.00	1.46	Long	Red purple
Arka Kesav	101.00	73.20	55.33	45.00	11.90	2.84	35.40	1.56	Long	Red purple
IC-112358	83.50	103.40	47.33	70.00	9.10	4.20	33.50	2.35	Round	Purple
IC-90984	86.50	97.40	50.67	75.00	6.58	3.54	47.00	3.53	Oval round	Light purple
Pusa Uttam	87.50	98.23	50.00	93.00	7.24	5.70	44.67	4.15	Oval	Dark purple
Pusa Purple Cluster	85.50	67.97	45.67	47.50	10.20	3.80	70.00	3.33	Long cluster	Violet purple
Udaipur Local	106.50	93.40	47.33	110.00	6.12	5.50	31.10	3.42	Round	Dark purple
Pusa Upkar	106.50	84.15	49.67	105.00	8.38	7.00	29.20	3.07	Round	Dark purple
Pusa Bhairav	119.50	69.30	46.67	98.00	9.80	3.70	33.10	3.25	Long.	Dark purple
Pusa Kranti	106.00	92.50	63.33	52.50	10.80	5.20	65.70	1.45	Oblong	Dark purple
Pusa Bindu	102.40	80.70	47.67	68.00	6.50	4.40	27.30	1.86	Oval round	Violet purple
Arka Kusumakar	87.70	89.40	56.33	47.50	9.50	3.50	69.40	3.30	Long cluster	Green
IC-112309	109.00	71.20	51.67	45.00	9.20	2.90	40.60	1.83	Long	Purple
Arka Sheel	71.00	75.10	55.00	65.20	10.00	3.00	32.20	2.10	Long	Dark purple
AHB-1	61.50	98.20	60.00	70.30	7.10	7.90	30.70	2.15	Round	Dark purple
AHB-2	63.30	99.40	65.33	72.30	6.10	5.70	30.50	2.21	Oval round	Dark purple
SEm ±	3.98	4.26	1.46	3.54	0.57	0.20	1.96	0.13	-	-
CD at 5 %	11.46	12.27	4.21	10.20	1.65	0.60	5.65	0.36	-	-

important yield contributing attribute in brinjal. Among the cultivars tested, PPC produced the highest number of fruits per plant (70.00) and was at par with Arka Kusumakar (69.40) and Pusa Kranti (65.70). It is due to more number of fruiting branches and clusters per plant bearing in these cultivars. Considerable diversity in fruit characters was recorded by Munshi and Behera (Munshi ad Behra, 2000) in chilli. Higher yield (4.15 kg/plant) in Udaipur Local was attributed due to more number of fruiting branches. The findings of present investigation are in agreement with the those of Deotale *et al.* (Deotale *et al.*, 1998).

In the present study, the superior genotypes identified based on fruit yield and quality, under extremes of arid environmental conditions, are Pusa Uttam, IC-90984, Udaipur Local and Pusa Purple Cluster.

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YIELD AND YIELD ATTRIBUTES OF MAIZE AS INFLUENCED BY GRADED LEVELS OF PHOSPHORUS FERTILIZATION IN SALT AFFECTED SOILS

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ABSTRACT

A field experiment was conducted in three soils *viz.*, normal, saline and sodic to optimize the best level of P for the maize variety Ganga. Seven levels of P viz., 0, 75, 100, 125, 150, 175 and 200 % recommended dose of P_2O_5 ha (RDP) in the form of super phosphate were added in each of the three soils. The results revealed that grain yield increased with increase in the levels of P application from 0 to 200% RDP in normal as well as in saline and sodic soils. However application of P @ 100% RDP in normal soil exhibited significant effect on grain yield (4.82 t/ha. But in case of saline and sodic soils, application of 125% RDP recorded significant effect on grain yield (4.00 t/ha in saline soil and 3.91 hal in sodic soil). A similar trend was observed in straw yield also. The yield attributing characters such as double cobs%, length and girth of the cob, 100 grain weight increased with increasing levels of P up to 100% RDP in normal soil and 125% RDP in saline and sodic soils. Thereafter no significant difference was observed with higher levels of P.

Key words : Grain yield, yield attributing characters, maize.

Maize is globally the top ranking cereal in potential grain productivity. Among the cereals grown in India, it ranks fifth in area (6.42 mha), fourth in production (11.47mt). third in productivity with such a low level of 1790 kg/ha (Statistical Abstract of India, 2000) It has also occupied a wide range of utility as a value based product in the industries of corn oil, starch, glucose, cosmetics, fermentation products (like alcohol, syrup), baby food, edible oil, poultry, live stock, fish feed, etc.

Among the major nutrients, phosphorus ranks next to nitrogen (N) in importance on account of its vital role in major life processes. Its availability to the growing crop in required levels is of prime importance in soil fertility. Phosphate fertilization is imminent to all crops for maximizing crop yield. Application of fertilizer phosphorus in balanced proportion with other essential nutrients produces high crop yields and ensures more profit to farmers. In India, for example, 7.0-26.1 M ha have been reported to be saline and sodic (Abdul Rashid, 2006).The transformation and availability of applied and soil P and crop responses to P application greatly differ in sodic and saline soils. As for Tamil Nadu is concerned the area under maize is increasing due to increase in broiler feed production day by day. As such the existing recommendation towards phosphorus fertilization to maize crop is far below the uptake in saline and sodic soils. Hence, the present investigation was planned to optimize the P dose to be applied for maize in the above soils.

MATERIALS AND METHODS

A field experiment was conducted during 2006 in three soils *viz.*, normal, saline and sodic to optimize the best level of P for the maize variety Ganga. The experimental field of normal soil is situated in Vadipatty village, Madurai district, whereas, the saline soil is situated in Thillaiyadi village, Cuddalore district and the sodic soil is situated in Kodairoad village, Dindigul district. Seven levels of P *viz.*, 0, 75, 100, 125, 150, 175 and 200 % recommended dose of P_2O_5/ha (RDP) in the form of super phosphate were added in each of the three soils. The recommended dose of P_2O_5 was 65 kg/ha. The treatments were replicated thrice in a randomized block design. N and K were applied common to all the plots as per the recommended dose. The experimental field of the normal soil was sandy clay loam in texture, neutral in reaction (pH 7.3), non saline in nature (EC 0.21 dSm^{-1}, less sodicity (SAR 4.7), low, in organic carbon (0.21%), low in available N (201 kg/ha), low in available P (9.63 kg/ha and high in available K (388 kg/ha). The saline soil was loam in texture, saline in reaction (pH 8.0, EC 4.1 dSm^{-1}, less in sodicity (SAR 8.27), low in organic carbon (0.2 1%), low in available N (172 kg/ha, low in available P (8.24 kg/ha, and high in available K (332 kg/ha. In case of sodic soil the texture was clay loam, alkaline in reaction (pH 8.9), non saline in nature (EC2.5 dSm^{-1}, high in sodicity (SAR 60.8), low in organic carbon (0.13%), low in available N (161 kg/ha) and P (8.01 kg/ha, and high in available K (316 kg /ha).

RESULTS AND DISCUSSION

Grain yield increased with increase in the levels of P application from 0 to 200% RDP in normal and both saline and sodic soils. However, application of P 100% RDP in normal soil exhibited significant effect on grain yield (4.82 t/ha). But, in case of saline and sodic soils, application of 125% RDP recorded significant effect on grain yield (3.95 t/ha in saline soil and 3.91 t/ha in sodic soil).

Similar trend was observed in straw yield also. Application of P 100% RDP in normal soil recorded significantly higher straw yield (10.96 t/ha whereas application of 125% RDP recorded significant increase in straw yield in saline and sodic soils (10.50 t/ha in saline soil and 10.12 t/ha in sodic soil).

The yield attributing characters such as double cobs %, length and girth of the cob, 100 grain weight were increased with increasing levels of P up to 100% RDP in normal soil and 125% RDP in saline and sodic soils. Thereafter no significant difference was observed with higher levels of P (Table 1). The increased levels of P accomplished the requirement of P nutrition and caused rapid root development that resulted in improved plant growth consequently showed significant translocation and storage of photosynthates from source to sink which resulted in significant enhancement in all the yield attributing characters and greater grain and straw yields. A similar trend was reported by Sutalia and Singh (2005) and Sahoo *et al.* (2001).

The salt affected soils such as sodic and saline required excess amount of P (125% RDP) than the normal soils (100% RDP). This might be due to the transformations and availability of applied and soil P and crop responses to P application differ in saline and sodic soils. Similar trends on P transformation in saline and sodic soils were also reported by Abdul Rashid (2006).

Similar trend was observed in straw yield also. Application of P 100% RDP in normal soil recorded significantly higher straw yield (10.96

Table 1. Effect of levels of phosphorus on yield attributing characters in maize crop

	Double cobs%			Length of the cob (cm)			Girth of the cob (cm)			100 grain weight (gm)		
	Normal	Saline	Sodic	Normal	Saline	Sodic	Normal	Saline	Sodic	Normal	Saline	Sodic
Control	44.22	36.28	34.54	16.00	12.70	11.70	13.00	10.20	9.30	18.00	15.76	14.36
75% RDP	52.14	43.25	42.29	18.50	14.70	13.60	16.50	12.70	11.50	22.75	18.10	16.90
100% RDP	56.83	46.57	45.51	19.90	16.20	14.90	18.60	14.20	12.80	25.50	19.50	18.58
125% RDP	56.98	49.88	48.03	20.00	17.30	15.90	18.70	16.00	14.30	26.00	20.80	19.61
150 % RDP	57.00	50.02	48.09	20.20	17.40	16.00	18.80	16.10	14.40	26.20	20.88	20.00
175% RDP	57.02	50.50	48.17	20.30	17.50	16.10	18.90	16.20	14.50	26.28	21.01	20.90
200 % RDP	57.09	51.03	48.03	20.40	17.60	16.20	19.00	16.30	14.60	26.54	21.14	20.24
SEm ±	1.31	1.15	1.1	0.46	0.40	0.37	0.44	0.37	0.32	0.61	0.48	0.46
CD at 5%	2.64	2.31	2.22	0.93	0.81	0.75	0.87	0.74	0.65	1.22	0.97	0.93

RDP - Recommended dose of phosphorus (65 kg/ha) t/ha whereas application of 125% RDP recorded significant increase in straw yield in saline and sodic soils (10.50 t/ha in saline soil and 10.12 t/ha in sodic soil).

The present study confirmed that the application of 100% RDP in normal soil and application of 125% RDP in saline and sodic soil boosted up the yield and yield attributing characters in maize crop.

Table 2. Effect of levels of phosphorus on grain and straw yield crop

Treatment	Grain yield (t/ha)			Strao yield (t/ha)		
	Normal	Saline	Sodic	Normal	Saline	Sodic
Control	3.77	3.10	3.01	9.52	8.90	8.30
75 % RDP	4.50	3.50	3.50	10.49	9.73	9.24
100 % RDP	4.82	3.75	3.70	11.00	10.16	9.70
125 % RDP	4.84	3.95	3.91	11.05	10.51	10.12
15O % RDP	4.86	4.01	3.93	11.06	10.55	10.16
175 % RDP	4.89	4.03	3.94	11.08	10.58	10.20
200 % RDP	4.93	4.04	3.98	11.11	10.62	10.22
SEm ±	0.11	0.07	0.09	0.04	0.07	0.18
CD at 5%	0.22	0.15	0.18	0.07	0.14	0.37

RDP - Recommended dose of phosphorus (65 kg/ha)

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DEVELOPMENT OF COMPOSTING TECHNIQUES FOR AQUATIC WEEDS

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ABSTRACT

Water hyacinth (*Eichhornnia crassipes*) and African payal (*Salvinia molesta*) are the major aquatic weeds found in the Kuttanad tract of Kerala. Composting is the best technique for safe and quick disposal of aquatic weeds. Since aquatic weeds produce large quantity of biomass, sizable amount of organic matter can be generated by composting them. Trials were conducted at RARS Kumarakom from_2001-2004 for quick composting using different additives, like urea, cowdung, trichoderma and pleurotus.The major aquatic weeds were *Salvinia* and *Eichhornia*. The results indicated that in heap method the best additive for composting salvinia was urea followed by cowdung and for *Eichhornia*, it was cowdung followed by *Trichoderma*. In tank method also cowdung was found to be the best additive for composting both aquatic weeds. The nutrient content of the composted material was better in tank method than in heap method.

Key words : *Salvinia, Eichhornia*, composting, *Trichoderma*, additive, heap method.

Weeds have become a serious problem in all water bodies. The low lying Kuttanad region which is situated below mean sea level is seriously infected with aquatic weeds. Aquatic weeds are defined as unwanted vegetation which grow and reproduce in water posing serious threat to Pisciculture, navigation, water supply conditions, channels etc., besides becoming hazardous to swimming, rowing and aquatic sports. *Eichhornia* or water hyacinth and African payal or Salvinia are the major aquatic weeds found in the Kuttanad area of Kerala. The disposal of these weeds is a major problem in these areas.

Aquatic weed management should aim at drawing maximum benefits from the weeds. For the safe and quick disposal of aquatic weeds, composting is the best technique which serves dual purpose. It yields good organic manure for sustainable agriculture and simultaneously reduces weed menace. Composting is a microbiological non polluting and safe method for disposal and recycling of organic wastes by bioconversion to manures. Microflora like bacteria, fungi and actinomycetes and microfauna which are widely distributed in nature are responsible in the bioconversion process. Since the aquatic weeds produce a large quantities of biomass, development of suitable technology for composting and vermicomposting will result in production of good organic manure and the problem of disposal of these weeds will be also overcome. With this view studies were undertaken on different aspects of composting of these aquatic weeds so as to produce good manure for crop plants.

MATERIALS AND METHODS

Since *Eichhornia* and *Salvinia* are the major aquatic weeds found in this tract, experiments were conducted using these aquatic weeds. Trials were conducted with different additives from 2001-2004 to find out the best additive for composting. The additives used were cow dung, urea, *Trichoderma and Pleurotus*. Composting was done in cement tanks. . Heap method of composting was also tried. Aquatic weeds were heaped in a cone shape having a radius of 1 m and at a height of 1.5 m. The heaps were covered with coconut fronds and watered frequently.

Compost percentage was calculated at monthly intervals by drawing samples. After taking samples fresh weight was recorded. These samples were dried in shade and sieved through 2 m and 4 m sieves for calculating compost percentage. Nutrient content of the compost samples were calculated using standard analytical methods. Samples were analysed for total nitrogen by Kjeldahl digestion and distillation method (Jackson 1973). Total phosphorus and potassium were estimated from diacid digested samples using Spectrophotometer and Flame photometer respectively (Bhargava and Raghupati; 1993).

RESULTS AND DISCUSSION

On visual observation composting was almost completed by five months. Compost percentage was estimated at monthly intervals by sieving through 2 m and finally 4 m sieve for comparing the percentage of composting as a standard measure.

Results indicated that in *salvinia* (Table 1) maximum compost percentage was produced by the application of urea at the rate of 20 g per kg of salvinia followed by the application of cowdung in the ratio 10: 1 and 10: 0.5. In *Eichhornia* composting (Table 2) was hastened by the addition of cowdung followed by *Trichoderma*. Urea had not much effect. Nutrient contents of compost did not show much variation when different additives were used. Data indicated that the best additives are cow dung and urea followed by trichoderma and pleurotus. Sannigrahi (2005) also reported that vermicomposting water hyacinth and other aquatic weeds.

Gaur (1990) reported that a rich and varied decomposing and humidifying micro flora is necessary for stabilizing the organic matter. Its presence at the beginning becomes a pre-requisite for reducing lag time and on setting an efficient process. The use of simple and natural inoculants like cattle dung slurry, organic soil, fresh compost are advantageous.

Nutrient content of *salvinia* and *Eichhornia* compost showed a better ratio when urea @ 20 g/kg of weed was used as an additive.

Aquatic weeds were composted in tanks using the same treatments. In tank method also the composting efficiency of salvinia also increased by the application of cow dung. For composting of *Eichhornia* in tanks the best additives were *Trichoderma* followed by cowdung. In tank method also nutrient content was better when urea was used as an additive.

Composting of salvnia was completed in 5 months. Here application of cowdung was fond to be better as in heap method. With regard to nutrient content higher content was noticed in samples using *pleurotus* as additive followed by urea. P and K did not vary much . N content is higher in tank method than heap method as nutrient loss is minimized. For *Eichhornea trichoderma* was found to be the best additive followed by cowdung. Nutrient content didn't show much variation in tank method.

Salvinia and *Eichhornia* can be composted using different additives. Among different additives cowdung was the best followed by urea for salvinia. And for Eichhornia the best additive was cowdung followed by *Trichoderma.*

Table 1. Effect of additives on compositing of Salvinia

Treatments	Compost Percentage		Nutrient content		
	4 mm sieve	2 mm sieve	N	P	K
Salvinia alone	1801	13.85	0.748	0.095	0.214
Salvinia + cowdung 10:1 ratio	24.22	19.25	0.465	0.184	0.502
Salvinia + cowdung 10:0.5 ratio	20.22	13.70	0.675	0.293	0.278
Salvinia + urea @ 10g/kg of weed	17.13	13.615	0.395	0.303	0.209
Salvinia + urea @ 20g/kg of weed	24.3	14.14	0.783	0.104	0.273
Salvinia + Trichoderma @ 15 g/kg of weed	19.98	14.14	0.255	0.116	0.225
Salvinia + Pleurotus @ 15g/kg of weed	18.1	13.06	0.395	0.157	0.178
CD at 5%	0.8	1.56			

Table 2. Effect of additives on composting of Eichhornea

Treatments	Compost Percentage		Nutrient content		
	4 mm sieve	2 mm sieve	N	P	K
Eichhornia alone	12.04	9.27	1.025	0.247	0.388
Eichhornia + cowdung 10:1 ratio	17.64	14.005	0.497	0.095	0.190
Eichhornia + cowdung 10:0.5 ratio	19.65	14.435	0.713	0.1	0.175
Eichhornia + urea @ 10g/kg of weed	12.32	9.385	0.692	0.256	0.255
Eichhornia + urea @ 20g/kg of weed	9.06	9.76	0.765	0.337	0.403
Eichhornia + Trichoderma @ 15 g/kg of weed	15.2	11.09	0.815	0.223	0.258
Eichhornia + Pleurotus @ 15g/kg of weed	13.27	9.685	0.433	0.209	0.179
CD at 5%	0.5	0.04			

Table 3. Effect of additives on composting of Salvinia in Tank method.

Treatments	Compost Percentage	Nutrient content		
	2 mm sieve	N	P	K
Salvinia alone	10.16	0.750	0.389	0.446
Salvinia + cowdung 10:1 ratio	18.04	1.380	0.396	0.350
Salvinia + cowdung 10:0.5 ratio	21.95	1.397	0.540	0.543
Salvinia + urea @ 10g/kg of weed	13.58	1.790	0.310	0.363
Salvinia + urea @ 20g/kg of weed	11.12	2.030	0.264	0.550
Salvinia + Pleurotus @ 15g/kg of weed	9.78	2.885	0.422	0.434
CD at 5%	0.29	1.175	0.323	0.493
Eichhornia alone	16.97	1.195	0.337	0.425
Eichhornia + cowdung 10:1 ratio	22.18	1.043	0.411	0.725
Eichhornia + cowdung 10:0.5 ratio	15.95	1.450	0.399	0.320
Eichhornia + urea @ 10g/kg of weed	15.91	1.118	0.505	0.231
Eichhornia + urea @ 20g/kg of weed	16.54	1.425	0.431	0.388
Eichhornia + Trichoderma @ 15 g/kg of weed	23.75			
CD at 5%	0.3			

Nutrient content of the compost was improved when urea was used. Nutrient content of the compost was better in tank method than in heap method.

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EFFECT OF MICRONUTRIENTS AND BIOFERTILIZER INOCULATION ON GRAIN YIELD, PROTEIN CONTENT, MICRONUTRIENTS CONTENT AND ECONOMICS OF CHICKPEA CROP

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ABSTRACT

A field experiment was conducted to evaluate the effect of micronutrients and biofertilizers on yield and economics of chickpea crop. The experiment was laid down in split plot design with four micronutrients alone and in combination of all, along with biofertilizers against the control. The highest grain yield (1866 kg/ha) was produced with the micronutrient treatment RDF + AM @ 1 kg/ha (M) followed by the combination of micronutrients viz. Fe, B, Zn and M0 (M6) 1477 kg/ha. Protein content in grain was significantly higher in all the micronutrient treatments as well as biofertilizers, except treatment M_2 (RDF+Fe+$FeSO_4$) over the control. It varied from 21.87-23.46 in micronutrient treatment and 22.15-23.47 in biofertilizer treatment experiments. Micronutrients content were recorded significantly higher over the control in grain and straw. Economics of various treatments indicate the maximum net return over control with the treatment RDF+AM @ 1 kg/ha + *Rhizobium* + PSB (Rs 1525/ha). The maximum B:C ratio (1:56.15) ratio was recorded with RDF + *Rhizobium* + PSB followed by with RDF + AM + *Rhizobium* + PSB (1:9.90).

Key words : Grain yield, nutrient content, economics.

Chickpea (*Cicer aerietimum* L.) is one of the major rabi crop which has high digestible dietary protein (17-21%) but its production is very low. The major constraints limiting production of chickpea is poor fertility status of the soil. The soils of this region are vertisols, which are slightly in alkaline, low in K and P and high in available potassium.

Chickpea productivity increases with adequate nutrition coupled with intensive cropping results in micronutrient deficiency. Their application in deficient soils enhance seed yield of regume crop (Chandel *et al.*, 1989). Use of biofertilizers can have greater impact in increasing fertilizer use efficiency by fixing atmosphere nitrogen and solublising active phosphorus (Subha Rao, 1986), consequently increase the economics of crop. Meager information is available on the response of chickpea to different fertility levels and biofertilizers, hence the present study was undertaken.

MATERIALS AND METHODS

The study was conducted at Sehor, Agricultural Farm, M.P., in 2003. The experiment was comprised in split plot design with six level of micronutrient in combination of recommended doses of NPK and levels of biofertilizers inoculation with replicated thrice. The soil has slightly alkaline pH (7.5), Ecso. 45 dS/m and organic carbon percent 0.40. Available NPK were 150, 12.45 and 368.93, 9.82 kg/ha, respectively. Micronutrients like available Zn, Fe, B and M0 were 2.15, 74.8, 0.015 and 0.10ppm, respectively. The treatments comprised of: M_1 control with no micro-nutrients and no biofertilizers inoculation; M_2 RDF+FeSO4 (10 kg/ha); M_3 RDF+Borex (10 kg/ha); M4 RDF+$ZnSO_4$ (25 kg/ha); M5 Ammonium Molybdate @ 1 kg/ha (M5), and M6 RDF+$FeSO_4$+Borax+ $ZnSO_4$+AM and two levels of biofertilizers inoculation (with Rhizobium+PSB and without this). Recommended dose of N, P, K and S were applied @ 20, 40, 20 and 20 kg/ha, respectively. Chickpea was sown in properly by seed drill with maintaining of proper row-to-row and plant-to-plant distances. Yield and yield attributing character was determined at time to time and yield data was taken after maturing the crop, which harvested by 2x2 m² area. The soil and plant was analyzed by standard procedure (Singh *et al.*, 1999).

RESULTS AND DISCUSSION

The data presented in Table 1 revealed that the highest grain yield (1866 kg/ha) was produced with the micronutrient treatment RDF+AM @1 kg/ha followed by the combination of micronutrients viz. Fe, B, Zn and M0 1477 kg/ha. Further, the treatment of RDF+AM @ 1 kg/ha and combination of all micronutrients (M6) increased the grain yield of chickpea significantly over the control and also over most of the other micronutrients treatments (M_2 and M_4).As regards biofertilizers inoculation *Rhizobium*+ PSB inoculation (I_1) could significantly increased the grain yield over no inoculation (I_0). Interaction between micronutrients and inoculation with *Rhizobium*+PSB was found non significant. Gupta *et al.* (1998) were also found similar result. Protein content in grain was significantly higher in all the micronutrient treatments as well as biofertilizers, except treatment M2 (RDF+$FeSO_4$) over the control. It varied from 21.87-23.46 in micronutrient treatment and 22.15-23.47 in biofertilizer treated experiments.

In regards to the micronutrient content (Zn, Fe and Bo), it revealed that these nutrients were recorded significantly higher over the control in grain straw (Table 3). The content of Zn in grain was higher, while Fe and Bo were higher in straw. These nutrients were higher over the control were higher in straw. These nutrients were higher over the control where these are applied alone or in combination of all the micronutrients. Biofertilizer inoculation with *Rhizobium*+PSB (I1) was found significantly superior over without inoculation (I0) in increasing this nutrient content in chickpea grain and straw. Interaction between micronutrients and biofertilizers (MxI) was no significant.

Economics of various treatments, Table 2 indicate the maximum bet return over control with the treatment RDF+AM @ 1 kg/ha +*Rhizobium*+PSB (Rs 15525/ha) followed by with RDF+AM @1 kg/ha alone (Rs 12042/ha). Hence, application of M0 @1 kg/ha in combination with *Rhizobium*+PSB found most profitable treatment. As regards B:C ratio, the maximum B:C ratio (1:56.15) ratio was recorded with RDF+Rhizobium+PSB followed by with RDF+AM+*Rhizobium*+PSB (1:9.90). However, the maximum return was observed in case of RDF+AM @1 kg/ha+*Rhizobium*+PSB and thus the practice can be used more profit.

Table 1. Grain yield and protein content of chickpea crop as influenced by micronutrients and biofertilizers

Treatment	Grain yield (kg/ha)	Protein content
Micronutrients (M)		
Control-RDF	1151	21.87
RDF+$FeSO_4$	1289	22.19
RDF+Borex	1297	22.25
RDF+$ZnSO_4$	283	22.50
RDF+Ammonium Molybdate	1866	23.12
RDF+$FeSO_4$+Borex+$ZnSO_4$+AM	1477	23.46
CD at 5%	185	1.35
Inoculation		
No inoculation	1313	22.15
RDF+Rh+PSB	1473	23.47
CD at 5%	107	0.17

Table 2. Economic of chickpea as influenced by different micronutrients and biofertilizers inoculation

Treatment	Additional Cost of Treatment Over control (a)	Yield (kg/ha) (b)	Additional yield increaseover control (c)	Cost of increase grain (Rs/ha) (d)	Net return over control e=(d-a)	B:C ratio over control g=(c/a)
Micronutrients (M)						
Control-RDF	0	1024	-	-	-	-
RDF+$FeSO_4$	1086	1192	168	3024	1934	1.78
RDF+Borex	1570	1268	244	4392	2822	1.80
RDF+$ZnSO_4$	2500	1209	185	3330	830	0.33
RDF+Ammonium molybdate	1458	1774	750	13500	12042	8.25
RDF+$FeSO_4$+Borex+$ZnSO_4$+AM	6614	1408	384	6912	298	0.05
RDF+Rh+PSB	80	1277	254	4572	4492	56.16
RDF+$FeSO_4$+Rh+PSB	1166	1386	364	6552	5486	4.70
RDF+Borex+Rh+PSB	1650	1325	301	5418	3768	2.28
RDF+$ZnSO_4$+Rh+PSB	4373	1356	332	5976	1603	0.37
RDF+AM+Rh+PSB	1538	1957	933	16758	15220	9.90
RDF+$FeSO_4$+Borex+$ZnSO_4$+ AM+Rh+PSB	6694	1538	514	925	2558	0.38

Note: Cost of iron sulphate @ Rs 108.6/kg, cost of Borex @ Rs 157/kg, Cost of zinc sulphate @ Rs 100/kg; cost of ammonium molybdate @ Rs 1458/kg; cost of Rhizobium+PSB with inoculation Rs 80; selling of chickpea-1800/q

Table 3. Zinc, iron and born content (ppm) in grain and straw of chickpea as influenced by different micronutrients and bio fertilizers inoculation

Treatment	Zn content (ppm)		Fe content (ppm)		Bo content (ppm)	
	Grain	Straw	Grain	Straw	Grain	Straw
Micronutrients (M)						
Control-RDF	17.0	9.00	62.00	380.00	12.00	18.00
RDF+$FeSO_4$	17.0	9.00	68.00	389.00	12.00	18.00
RDF+Borex	17.0	9.00	63.00	380.00	15.00	20.00
RDF+$ZnSO_4$	20.00	10.00	63.00	380.00	13.00	18.00
RDF+Ammonium molybdate	17.0	9.00	66.00	381.00	14.00	18.50
RDF+$FeSO_4$+Borex+$ZnSO_4$+AM	21.0	10.00	62.00	385.00	14.00	20.00
CD at 5%	0.65	0.38	2.51	4.25	1.79	1.95
Inoculation (I)						
No inoculation	18.0	9.00	63.00	380.00	13.00	18.00
RDF+Rh+PSB	20.00	10.00	67.00	385.00	14.00	19.50
CD at 5%	0.45	0.75	1.02	2.15	0.80	0.95

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CROP INTENSIFICATION IN NENDRAN BANANA BASED CROPPING SYSTEM FOR HIGHER YIELD AND PROFITABILITY

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ABSTRACT

The influence of crop intensification in banana variety Nendran by modifying the planting pattern and intercropping on productivity enhancement and thereby income was evaluated by conducting field investigation at College of Agriculture, Vellayani during 2002-2003 and 2003-2004.The investigation was laid out in factorial randomised block design with two systems of planting and four intercrops, replicated thrice. Individual bunch weight did not register any variation with planting pattern .However maximum yield per hectare was registered in modified system of planting. Combination of modified planting pattern with cucumber-amaranthus recorded the highest net profit and BCR.

Key words : : Banana, crop intensification, high density planting, yield, economics.

Banana cultivation being a high input and high risk enterprise has to be ensured of its economic advantage particularly to the small and marginal farmers who invest most often borrowed capital in the cultivation. Nendran is the most popular cultivar in the state owing to its adaptability to varying environments, yield stability, excellent fruit quality attributes sustained income and multiple uses. Inefficient use of resources not only results in increased cost of production and reduced profitability but also proves detrimental to the natural resources. The present work was undertaken, to facilitate higher productivity of banana per unit area with optimised use of inputs besides maximising returns from other intercrops and safeguarding the natural resource base. High density planting is such a novel technique which when judiciously planned in combination with other inputs at optimum level has broken the yield plateau in some horticultural crops. Intercropping in banana is intended to maximise the land and space use efficiency to generate supplemental income, particularly during the initial unproductive phase of banana. Enhanced banana yield by modifying the planting pattern and increasing the productivity by intercropping will be remunerative to the farmer.

MATERIALS AND METHODS

The investigation was undertaken at the Instructional Farm, College of Agriculture, Vellayani during the period 2002-2003 and 2003-2004. The soil of the experimental area was clay loam hypothermic family of Rhodic Haplustox. The investigation was intended to study the effect of planting pattern and intercrops on the productivity and profitability of banana variety Nendran. The experiment was laid out in 2 x 4 Factorial Randomised Block Design with eight treatments and three replications. The plot size used was 12 m x 4 m. The treatments consists of normal pattern with 2 m x 2 m spacing (2500 plants/ha) (P_1), modified pattern with 3 m x 2 m spacing and planting two suckers per pit (3333 plants/ha) (P_2); nontercrop (C_0), vegetables-cucumber followed by amaranthus i.e., (2 intercrops for one crop of banana) (C_1), tuber crop- colocasia (one intercrop for one crop of banana) (C_2) and medicinal plant- chittaratha (one intercrop for two crops of banana) (C_3).

Residues of the intercrops were recycled in the same plot after harvest. Management practices were followed as per the POP Recommendations, Kerala Agricultural University (2002). The experimental data were analysed statistically by applying the techniques of analysis of variance

(Panse and Sukhatme, 1985). Pooled analysis of yield and net income was done.

RESULTS AND DISCUSSTION

Pooled data of yield for two years varied significantly with planting pattern. However it remained insignificant with intercrops and its interaction with planting pattern. Pooled yield was maximum under modified system of planting. Overall review of the results clearly indicated that planting of Nendran at 3 m x 2 m with two suckers per pit is better than planting single sucker at 2 m x 2 m spacing for getting maximum yield per unit area with good sized bunches. This practice of double sucker planting at a spacing of 3 m x 2 m can improve the yield by about 22 to 26 per cent than normal system (Table 1). Differences in bunch size between conventional planting and modified planting is very less. Yield in banana is a function of number of bunches per hectare and individual bunch weight. The better effect of modified system is due to 33 per cent more plant population in the system thereby increasing productivity. Adopting high density planting with two suckers per pit at 3 m x 2 m spacing enables intercropping which led to substantial increase in economic return without affecting the quality of the bunch. None of the intercrops had any negative influence on the bunch weight of banana. Moreover, the incorporation of the intercrop residues had the added advantage of soil nutrient improvement. Economic analysis had revealed that pooled net income showed significance with planting pattern and intercrops. Modified system of planting among planting systems and cucumber -amaranthus among intercrops proved superior to all other treatments. The highest net income (Rs.584707) and BCR (7.1) was obtained when banana was intercropped with cucumber - amaranthus. Intercropping is an added source of income to farmer. Hence it could be inferred that cucumber -amaranthus and colocasia are equally good as intercrop in banana raised in modified planting. Growing chittaratha is more economic than pure crop. However when compared with other intercrops it is less economic since the expenditure for initial establishment is high and returns will be obtained only after 18 months. Raising profitable intercrops is suggested as a viable alternative for the better utilization of resources and increasing income. Therefore it can be concluded from the study that planting banana variety Nendran at 3 m x 2 m spacing with two suckers/pit and raising cucumber-amaranthus as intercrop is beneficial for getting higher yield per unit area and maximum economic returns.

Table 1. Effect of planting pattern and intercrops on the yield and economics of banana var. Nendran

	Pooled yield (t/ha)	pooled net income (Rs.)	Benefit : cost ratio
Planting pattern			
P_1	26.90	345826	3.82
P_2	33.34	452004	5.44
$F_{1,14}$	43.91**	78.23**	128.13**
SEm ±	0.69	8488.8	0.144
CD	1.97	24370.1	0.308
Intercrops			
c_0	29.01	310430	3.97
c_1	31.61	504851	5.81
c_2	29.22	417670	3.38
c_3	30.63	362709	5.36
$F_{3,14}$	1.60ns	47.91**	63.18**
SEm±	0.97	12004.9	0.203
CD	-	34464.5	0.436
Interaction			
p_1c_0	26.47	271612	3.32
p_1c_1	29.04	424995	4.53
p_1c_2	26.05	377903	2.94
p_1c_3	26.04	308796	4.47
p_2c_0	31.55	349249	4.61
p_2c_1	34.19	584707	7.10
p_2c_2	32.39	457438	3.82
p_2c_3	35.21	416623	6.24
$F_{3,14}$	0.97ns	2.54ns	6.37**
SEm±	1.370	16977.6	0.288
		-	0.617

ns - not significant *Significant at 5 per cent level **Significant at 1 per cent level

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GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE FOR YIELD AND ITS ATTRIBUTES IN POTATO (*SOLANUM TUBEROSUM* L.)

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ABSTRACT

Forty four genotypes were evaluated for thirteen characters. Characters marketable yield, total tuber yield and number of tubers per plant had higher genotypic and phenotypic coefficient of variation, whereas the moderate magnitude of PCV and GCV was observed for per cent emergence, fresh weight of shoots/plant and plant height. High heritability estimates for the characters fresh weight of shoots/plant, harvest index, dry weight of tubers/plant, per cent emergence, total number of leaves/plan, fresh weight of tubers/plant total tuber yield/plot, plant height and dry weight of shoots/plant. High genetic advance as percentage of mean was obtained for characters namely dry weight tubers/plant and total tuber yield/plot. High heritability coupled with high genetic advance was recorded for the traits viz. dry weight of tubers and total tuber yield/plot. Result reveal that the genotypic coefficient of variation, high heritability and genetic advance may be exploited in further breeding programme.

Key words : Potato, variability, heritability, GCV, PCV, genetic advance.

The history of potato is the testimony of the fact that whenever, there has been scarcity of food grains, potato has become the food security of people. Potato, because of its great utility, occupies a pre-eminent place amongst the crops and acknowledges as the "king of vegetables". Potato is an essential crop and has received great attention in the recent past, as it fits well in the multiple and inter cropping systems. Considering the importance of the crop there is needed to improve its yield. Yield is a complex character which is highly influenced by environment. Development of high yielding cultivar is a continuous process and there is an urgent need to select best hybrid or culture suitable for growing in Chhattisgarh State. Considering the past increase in potato area and lack of suitable variety for this State it is necessary to find out suitable genotype of potato for Chhattisgarh Plains.

MATERIALS AND METHODS

Forty four genotypes of potato obtained from CPRI and AICRP, Shimla (H.P.) maintained at Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) were grown in randomized block design with three replication of plot size 1.2 m x 3.0 m and 60 X 20 cm spacing during the year 2006-07. All the recommended package of practices was followed for the raising of good crop. The crop was harvested 75 days after planting and observations were recorded on five plants in each genotypes and each replication and there means were calculated. Data were subjected to statistical analysis as per Panse and Sukhatme (1978) method. The genetic parameters like GCV and PCV were estimated according to Burton (1952), heritability as suggested by Hanson et al. (1956) and genetic advances as percentage of mean as given by Johnson *et al.* (1955a).

RESULTS AND DISCUSSION

Mean sum of square due to genotypes were significant for all the characters suggesting presence of considerable genetic variation in respect of various characters. The analysis of variance indicated the existence of sufficient amount of variability among genotypes for all the characters studied which is indicating that the genotypes were widely variable. In the present study, the phenotypic variance was in general higher than the genotypic variance for

Table 1. Analysis of variance for tuber yield and its components

Characters	Mean of sum of square		
	D.F. = 2	D.F. = 43	D.F. = 86
Plant height/plant in cm	63.0*	125.3**	13.5
No. of shoots/plant	3.9*	3.4*	1.1
Total no. of leaves/plant	13.4	351.2**	18.5
No. of branches/plant	39.0**	34.1**	5.5
Fresh weight of shoots/plant (g)	12.5	164.5**	22.3
Dry weight of shoots/plant (g)	8.0	47.1**	5.6
Fresh weight of tubers/plant (g)	0.007	0.011**	0.008
Harvest index (%)	118.0	11915.9**	214.0
No. of tubers/plant	1.0	14.13*	3.7
Dry weight of tubers/plant (g)	42.9	1241.0**	30.5
Per cent emergence (%)	222.2**	719.9**	26.9
Marketable yield plot (kg)	11.9**	10.1**	1.4
Total yield/plot (kg)	10.8**	11.9**	1.2

*, **Indicate significant at 5% and 1% levels, respectively.

all the characters. Thus it suggests the substantial influence of environment besides the genetic variation for expression of these traits.

The genotypic and phenotypic coefficient of variation were higher for marketable yield (kg plot^{-1}) followed by total tuber yield (kg plot^{-1}) and number of tubers per plant whereas, the moderate magnitude of PCV and GCV (15-20 per cent) was observed for per cent emergence followed by fresh weight of shoots plan^{t-1} and plant height. The PCV and GCV observed with low magnitude for fresh weight of tuber per plant. These findings are in accordance with the findings of Chaudhary and Sharma (1984) for tuber yield, number of tuber plant^{-1} and average tuber weight; Garg and Bhutani (1991) for total tuber yield and average tuber weight of tuber plant^{-1}; Dixit *et al.* (1991) for stems plant^{-1}; Sharma (1999) for dry weight of shoots plant^{-1}; Bhagowati (2002) for leaves number plant^{-1} ; Kumar *et al.* (2005) for average tuber weight for tuber number, plant height and average tuber yield by Joseph (2005); for tuber weight and number of haulms hill^{-1} by Shashikamal (2006).

The heritability estimates high for the characters fresh weight of shoots plant^{-1} followed by harvest index, dry weight of tubers plant^{-1}, per cent emergence, total number of leaves plant^{-1}, fresh weight of tubers plant^{-1}, total tuber yield plot^{-1}, plant height and dry weight of shoots plant^{-1}. Similar results were also reported earlier for the characters total tuber yield plant^{-1}and average tuber weight Choudhary and Sharma (1984) stem plant^{-1} Dixit *et al.* (1994) dry weight of tuber Sharma (1999), average tuber weight, number of tubers and plant vigour Luthra (2001), tuber yield, number of tuber Luthra *et al.* (2005) and for per cent emergence, total tuber yield, harvest index and dry matter percentage Roy and Singh (2006).

In the present investigation high genetic advance as percentage of mean was obtained for characters namely dry weight tubers plant^{-1} and total tuber yield plot^{-1}. The high value of genetic advance for these traits showed that these characters are governed by additive genes and selection will be rewarding for the further improvement of such traits. The moderate genetic advance observed in characters namely harvest index, fresh weight of shoots plant^{-1}, number of branches plant^{-1}, per cent emergence, dry weight of shoots plant^{-1}, number of tubers plant^{-1}, total number of leaves plant^{-1}, plant height and fresh weight of tuber plant^{-1}. These findings of moderate genetic advance suggest that both the additive and non-additive variance are operating in these traits However, the low genetic advance as per cent of mean was

Table 2. Genetic variability of tuber yield and its components

Parameters	Mean	Range		σ^2p	σ^2g	σ^2e	P.C.V. (%)	G.C.V. (%)	h^2b	Genetic Advance K=2.06	Genetic Advance as % of mean
Characters		Minimum	Minimum								
Plant height (cm)	42.38	31.07	56.40	50.75	37.25	13.50	16.81	14.41	73.40	10.78	25.44
No. of shoots/plant	4.77	2.93	7.72	1.86	0.75	1.11	28.61	18.61	40.30	1.13	23.69
Total No. of leaves/ plant	67.86	43.00	87.71	129.35	110.85	18.50	16.76	15.52	85.70	20.09	29.61
No. of branches/ plant	14.93	8.69	23.87	15.02	9.54	5.48	25.96	20.68	63.50	5.07	33.96
Fresh weight of shoot (g/plant)	147.92	94.11	89.42	669.32	647.32	22.09	17.49	17.20	96.70	51.54	34.84
Dry weight of shoots (g/plant)	20.61	12.12	28.08	19.398	13.85	5.56	21.37	18.06	71.40	6.48	31.44
Fresh weight of tubers (g/plant)	0.44	0.31	0.57	0.004	0.0033	0.0007	14.52	13.12	81.60	0.11	25.00
Harvest index (%)	317.06	193.57	487.35	4114.1	3900.2	214.0	20.23	19.70	94.80	125.27	39.51
No. of tubers/plant	9.00	4.50	14.60	7.155	3.48	3.70	29.72	20.74	48.70	2.68	29.78
Dry weight tubers (g/plant)	79.89	39.15	130.15	434.11	403.72	30.40	26.08	25.15	93.00	39.90	49.94
Per cent emergence %	82.69	31.83	100.00	257.87	231.05	26.90	19.42	18.38	89.60	26.64	32.21
Marketable yield (kg/plot)	6.33	2.35	9.88	4.32	2.89	1.44	32.83	26.83	66.80	2.86	0.45
Total yield (kg/plot)	7.23	2.46	11.84	4.78	3.61	1.20	30.25	26.29	75.60	3.40	47.03

observed for the character, number of leaves plant^{-1}, number of shoots plant^{-1} and marketable tuber yield . In agreement to the above results, similar findings were also supported by Chaudhary and Sharma (1984) for tuber yield; whereas; Sharma (1999) for fresh weight of tuber plant^{-1}, Luthra (2001) for tuber yield; Luthra *et al.* (2005) for tuber yields; Ikbal & Khan (2003) reported high genetic advance for plant height and number of shoots plant^{-1}; Roy and Singh (2006) for tuber yields and dry matter of percentage and Kumar *et al.* (2005) for tuber yield.

High heritability coupled with high genetic advance was recorded for the traits viz. dry weight of tubers (g plant^{-1}) and total tuber yield plot^{-1}. Hence, these characters were predominantly governed by additive gene action and can be improved through simple selection.

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CRITICAL PERIOD OF WEED-CROP COMPETITION AND WEED DYNAMICS IN TRANSPLANTED *KHARIF* RICE UNDER TERAI AGRO-CLIMATIC REGION OF WEST BENGAL

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ABSTRACT

Weed is a constraint in transplanted *kharif* rice accounting yield loss to the tune of 56 to 58 % if it is left uncontrolled. Critical period of weed-crop competition has been determined from 20 days after transplanting (DAT) to 40 DAT and yield obtained through weeding only during critical period of weed-crop competition was 3% lower than that of season long weed free situation. Among the weeds appeared in transplanted *kharif* rice, *Ludwigia parviflora* Roxb. and *Echinochloa crus-galli* had long emergence profile followed by Monochoria hastata Prest and *Sphenochlea zeylanica* whereas *Cyperus iria* L. and *Fimbristylis miliacea* (L) Rahl. had narrow emergence profile.

Key words : Weed-crop competition, weed dynamics.

Rice grain production in India suffers yearly loss of 15 million tones due to weed-crop competition (Chatterjee and Maity, 1981). The reduction in yield of transplanted rice was estimated to the tune of 15-45% due to weed infestation depending on the soil type, rainfall and season (Pillai and Rao, 1974). IRRI suggested that weed growth in unweeded plots reduced yield by as much as 34% in transplanted rice. Therefore, the productivity of rice to a great extent depends on efficient resource management particularly weeds as alternate wetting and drying condition prevailing during crop growth period encourage heavy weed growth accounting for 28-48% yield loss (Singh and Bhan, 1986). Serious damage to rice yields are primarily attributed due to weed-crop competition occurs at the initial stage of the crop growth. Competition from weeds during early growth stage of rice is more serious than weed-crop competition at later growth stages. Therefore, control of weeds during critical period of weed-crop competition helps to achieve high yields of rice (De Datta *et al.*, 1969). This led to the need to determine critical period of weed crop competition for developing weed control practices in kharif rice under Terai agro-climatic region of West Bengal.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* season of 2006 and 2007 at research farm of Uttar Banga Krishi Viswavidyalaya. Ten treatments for critical period of weed-crop competition have been formulated on the basis of methodology suggested by Nieto et. al. (1968). Among the treatments, four treatments comprised weedy condition maintained up to 20 DAT, 40 DAT, 60 DAT and 80 DAT then weed free afterwards. In another four treatments weed free condition was maintained up to 20 DAT, 40 DAT, 60 DAT and 80 DAT then weedy afterwards. Remaining two treatments comprised season long weed free situation and season long weedy situation. These treatments have been tested in Randomized Complete Block Design with three replications. In addition to this Absolute density, Relative density, Absolute frequency, Relative frequency, Importance value index and Summed dominance ratio of the weeds appeared in *kharif* transplanted rice have been determined by the formula suggested by Raju (1997).

RESULTS AND DISCUSSION

Weed flora in transplanted kharif rice

Among the grasses *Echinochloa crus-galli*, broadleaved weeds *Monochoria hastata*, Ludwigia *parviflora*, *Sphenochlea zeylanica* and sedges *Cyperus iria* and *Fimbristylis miliacea* became dominant weed flora in transplanted *kharif* rice. At 20 DAT broadleaved weeds *Monochoria hastata* became had high importance value index (71.77) and summed dominance ratio (35.88) in comparison to other broadleaved weeds like Nymphoides indicum and *Ludwigia parviflora*. However, after 20 DAT population of *Monochoria hastata* declined and *Ludwigia parviflora* flourished well and became dominant during 40 DAT and 60 DAT, which resulted in high importance value index of 94.94 and 52.75 and summed dominance ratio of 47.47 and 26.40, respectively. After 60 DAT another broadleaved weeds *Phenochlea zeylanica* appeared and became aggressive in remaining part of the crop growth. This resulted in high importance value index and summed dominance ratio with the value of 32.81 and 16.40, respectively during 80 DAT and 41.36 and 20.68, respectively during 100 DAT. Sedges appeared at the letter part of the crop growth and became suppressed by the high growth rate of broadleaved weeds. Grasses mainly *Echinochloa crus-galli* multiply well at the latter part of the growth phase and it had highest importance value index of 42.67 and 40.56 and summed dominance ratio of 21.34 and 20.28 at 80 DAT and 100 DAT, respectively compared with other broadleaved weeds and sedges. Table 2, 3, 4, 5 and 6 revealed the fact that weed flora of transplanted *kharif* rice encompassed 8 weed species of which 1 belonged to grass, 4 to sedge and 4 to broadleaved weed. At the initial phase of crop growth, *Monochoria hastata* became dominant and constituted an important weed during 20 DAT. *Ludwigia perennis* took up high growth rate after 20 DAT and became dominant weed along with *Monochoria hastata* up to 40 DAT. Population of *Monochoria hastata* decreased as it died rapidly beyond this stage making *Ludwigia parviflora* became dominant weed flora up to 60 DAT. Another broadleaved weed *Sphenochlea zeylanica* emerged after 60 DAT, however, high growth rate of this weed made it a dominant weed along with *Ludwigia parviflora* during 80 DAT. At the terminal growth stage of the crop the broadleaved weeds *Sphenochlea zeylanica*, the grass *Echinochloa crus-galli* and the sedge *Scirpus maritimus* constituted the dominant weed flora. Among the weed flora appeared in transplanted kharif rice, *Ludwigia perennis* and *Echinochloa crus-galli* had long emergence profile followed by *Monochoria hastata* and *Sphenochlea zeylanica* whereas the weeds *Cyperus iria* and *Fimbristylis miliacea* had narrow emergence profile.

Critical period of crop-weed competition in transplanted kharif rice

Data on yield attributing characters like filled grain per panicle, number of panicle per sqm, test weight and ultimate grain yield (Table 1) has revealed that highest values of these parameters were obtained in complete weed free situation during the crop growth, which was statistically at par with the treatments where weed free condition was maintained up to 80 DAT, 60 DAT and 40 DAT then weedy afterwards and weedy condition up to 20 DAT then weed free condition afterwards. The result showed that weed free period up to 80 DAT, 60 DAT and 40 DAT then weedy afterwards did not differ significantly with season long weed free situation in terms of yield and yield attributing characters. The result also revealed that weed growth up to 20 DAT then weed free afterwards did not make significant difference on crop performance with regard to season long weed free situation. From the above findings the critical period of crop-weed competition in transplanted rice could be determined from 20 days after transplanting to 40 days after transplanting the shortest period when weeding resulted in highest economic return through reduction of weed-crop competition for several growth factors.

Yield reduction due to weed in transplanted kharif rice

In transplanted *kharif* rice weedy situation throughout the crop growth accounted yield reduction to the tune of 58% (Table 1) in comparison to season long weed-free condition. However, weeding during the critical period i.e.

Table 1. Weed dry weight (g/m2) at harvest, yield attributing characters, yield (kg/ha) and yield reduction (%) of transplanted *kharif* rice due to weed

Treatment	Weed dry weight (g/m²)		1000 grain weight (g)		Filled grain/panicle		Panicles/ m²		Yield (kg/ha)		Yield reduction (%)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Weedy up to 20 DAT then weed free	0.00	0.00	20.38	20.22	71.33	72.41	178.67	188.67	2745.90	2813	2.17	3.16
Weedy up to 40 DAT then weed free	0.00	0.00	20.72	20.84	57.67	56.39	147.00	145.00	1878.20	1874	33.08	35.48
Weedy up to 60 DAT then weed free	0.00	0.00	20.91	20.95	48.00	46.28	140.67	140.31	1346.70	1358	52.02	53.26
Weedy up to 80 DAT then weed free	0.00	0.00	20.72	20.74	47.33	49.33	124.67	121.67	1265.50	1239	54.91	57.34
Weed free up to 20 DAT then weedy	152.46	167.37	20.60	20.67	61.67	63.87	148.67	151.67	1944.90	1974	30.70	32.03
Weed free up to 40 DAT then weedy	70.38	74.38	20.36	20.44	70.67	72.66	177.33	179.33	2700.60	2801	3.78	3.56
Weed free up to 60 DAT then weedy	36.17	29.17	20.46	20.45	71.33	75.33	178.67	178.33	2770.80	2821	1.28	2.89
Weed free up to 80 DAT then weedy	16.43	21.43	20.79	20.79	72.00	72.00	179.33	179.33	2798.10	2898	0.31	0.22
Season long weed free condition	0.00	0.00	20.55	20.55	73.00	73.00	179.67	179.67	2806.80	2905	-	-
Season long weedy condition	202.13	217.16	20.65	20.65	43.33	42.33	121.67	119.67	1208.80	1217	56.93	58.11
LSD (p=0.05)	-	-	NS	NS	3.13	3.21	4.42	4.54	116.99	126.15	-	-

Table 2. Weed flora in transplanted *kharif* rice appeared at 20 days after transplanting

Treatment	Family	Total		Absolute Density (%)		Relative Density (%)		Absolute Frequency (%)		Relative Frequency (%)		Importance Value Index		Summed Dominance Ratio	
		2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Monochoria hastata Prest	Pontederiaceae	66	58	22.00	19.33	48.53	46.77	100	100	25	25	73.53	71.77	36.76	35.88
Nymphoides indicum	Alismataceae	19	09	6.33	3.00	13.97	7.26	100	100	25	25	38.97	32.26	19.49	16.13
Ludwigia parviflora Roxb.	Onagraceae	30	42	10.00	14.00	22.06	33.87	100	100	25	25	47.06	58.87	23.53	29.43
Echinochloa crus-galli	Poaceae	21	15	7.00	5.00	15.44	12.10	100	100	25	25	40.44	37.09	20.22	18.55

Table 3. Weed flora in transplanted *kharif* rice appeared at 40 days after transplanting

Treatment	Family	Total		Absolute Density (%)		Relative Density (%)		Absolute Frequency (%)		Relative Frequency (%)		Importance Value Index		Summed Dominance Ratio	
		2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Monochoria hastata Prest	Pontederiaceae	49	52	16.33	17.33	14.37	15.47	100	100	25	25	39.37	40.47	19.68	20.24
Nymphoides indicum	Alismataceae	12	12	4.00	4.00	3.52	3.57	100	100	25	25	28.52	28.57	14.26	14.28
Ludwigia parviflora Roxb.	Onagraceae	223	235	74.33	78.33	65.40	69.94	100	100	25	25	90.40	94.94	45.20	47.47
Echinochloa crus-galli	Poaceae	57	37	19.00	12.33	16.72	11.01	100	100	25	25	41.72	36.01	20.86	18.00

Table 4. Weed flora in transplanted *kharif* rice appeared at 60 days after transplanting

Treatment	Family	Total		Absolute Density (%)		Relative Density (%)		Absolute Frequency (%)		Relative Frequency (%)		Importance Value Index		Summed Dominance Ratio	
		2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Monochoria hastata Prest	Pontederiaceae	2	12	0.66	4.00	1.45	6.15	33.33	100	7.69	14.28	9.14	20.44	4.57	10.22
Nymphoides indicum	Alismataceae	3	5	1.00	1.67	2.17	2.56	33.33	100	7.69	14.28	9.87	16.85	4.93	8.43
Ludwigia parviflora Roxb.	Onagraceae	51	75	17.00	25.00	36.40	38.46	100	100	23.08	14.28	60.03	52.75	30.01	26.40
Echinochloa crus-galli	Poaceae	46	52	15.33	17.33	33.33	26.66	100	100	23.08	14.28	56.41	40.95	28.21	20.47
Cyperus iria L.	Cyperaceae	7	25	2.33	8.33	5.07	12.82	33.33	100	7.69	14.28	12.76	27.10	6.38	13.55
Scirpus maritimus L.	Cyperaceae	9	7	3.00	2.33	6.52	3.58	66.66	100	15.38	14.28	21.91	17.87	10.95	8.93
Fimbristylis miliacea (L.) Rahl	Cyperaceae	20	19	6.66	6.33	14.49	9.74	66.66	100	15.38	14.28	29.88	24.02	14.94	12.01

Table 5. Weed flora in transplanted *kharif* rice appeared at 80 days after transplanting

Treatment	Family	Total		Absolute Density (%)		Relative Density (%)		Absolute Frequency (%)		Relative Frequency (%)		Importance Value Index		Summed Dominance Ratio	
		2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Ludwigia parviflora Roxb.	Onagraceae	28	48	9.33	16.00	12.17	21.52	100	100	20.00	16.67	32.17	38.19	16.09	19.09
Sphenochlea zeylanica	Campanulaceae	65	36	21.67	12.00	28.26	16.14	100	100	20.00	16.67	48.26	32.81	24.13	16.40
Echinochloa crus-galli	Poaceae	73	58	24.33	19.33	31.74	26.00	100	100	20.00	16.67	51.74	42.67	25.87	21.34
Scirpus maritimus L.	Cyperaceae	44	39	14.67	13.00	19.13	17.49	100	100	20.00	16.67	39.13	34.15	19.56	17.08
Fimbristylis miliacea (L.) Rahl	Cyperaceae	14	20	4.67	6.67	6.09	8.97	66.66	100	13.33	16.67	19.42	25.64	9.71	12.82
Cyperus iria(L.)	Cyperaceae	6	22	2.00	7.33	2.61	9.86	33.33	100	6.66	16.67	9.27	26.53	4.64	13.26

Table 6. Weed flora in transplanted *kharif* rice appeared at 100 days after transplanting

Treatment	Family	Total		Absolute Density (%)		Relative Density (%)		Absolute Frequency (%)		Relative Frequency (%)		Importance Value Index		Summed Dominance Ratio	
		2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Ludwigia parviflora Roxb.	Onagraceae	36	36	12.00	12.00	17.65	14.57	100	100	20.00	16.67	37.65	31.24	18.82	15.62
Sphenochlea zeylanica	Campanulaceae	48	61	16.00	20.33	23.53	24.69	100	100	20.00	16.67	43.53	41.36	21.76	20.68
Echinochloa crus-galli	Poaceae	70	59	23.33	19.67	34.31	23.89	100	100	20.00	16.67	54.31	40.56	27.16	20.28
Scirpus maritimus L.	Cyperaceae	36	38	12.00	12.67	17.65	15.39	100	100	20.00	16.67	37.65	32.05	18.82	16.03
Fimbristylis miliacea (L.) Rahl	Cyperaceae	10	25	3.33	8.33	4.90	10.12	66.66	100	13.33	16.67	18.23	26.78	9.11	13.39
Cyperus iria(L.)	Cyperaceae	4	28	1.33	9.33	1.96	11.33	33.33	100	6.67	16.67	8.63	28.00	4.31	14.00

from 20 DAT to 40 DAT minimized weed-crop competition and only yield reduction of 2.89 to 3.16% was recorded as compared to season long weed-free condition. However, weedy condition during the critical period resulted in yield reduction on account of 32 to 35%.

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DIFFERENTIAL EFFECTS OF DAY AND NIGHT TEMPERATURES ON GROWTH OF WHEAT CROP

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ABSTRACT

Climate change is no longer a distant threat, it is an emerging reality. Climate change is the defining challenge of our generation. High temperature. an imminent product of global climate change will affect agriculture through direct and indirect effects on crops. The daily minimum night time temperature increased at a faster rate than daily maximum temperature in the last century and differential increase in day and night temperature occurs for many parts of the world. Two popular wheat cultivars *viz.* PBW 343 and UP 2333 were subjected to different thermal treatments such as normal ambient temperature + 2.4°C during day and night + 2.8°C during daytime only and + 2.1°C during night time only from seedling establishment to maturity. In general, HDNT (T_1) followed by HDT (T_2) and HNT (T_3) affected the crop growth. So, high day and night temperature, product of climate change have significant impacts on wheat production systems.

Key words : Climate change,wheat, high temperature.

Agriculture plays a key role in overall economic and social well being of India. Rice and wheat crop production is a long established grain production system in India. This formed the foundation for green revolution and became backbone of India's food, nutritional, livelihood and economic security (Prasad, 2005).

The imminent products of climate change can have tremendous impact on agricultural production and hence, food security of any region. The rising temperatures and carbon dioxide and uncertainties in rainfall associated with global warming may or may not have serious direct and indirect consequences on crop production (Aggarwal, 2003). Climate influences plant life in many ways and can inhibit, stimulate, alter or modify crop performance. Its components (temperature, solar radiation. rainfall, relative humidity and wind velocity) independently or in combination, can influence crop growth and productivity. (Watson *et al.*, 1996). Crop response to a change in temperature depends on the temperature optima of photosynthesis, growth, and yield, all of which may differ (Conroy *et al.*, 1994). Lobell *et al.*, (2005) reported that in case of wheat, there exist a significant negative yield response to higher night time temperatures (roughly 10% reduction of yield for Tmin= 1°C) with a much smaller and statistically insignificant effect of daytime temperature and solar radiation. Heat stress negatively affected grain yield and its components (Tahir and Nakata, 2005). Weather and climate affect the plant growth and development, and the fluctuations and occurrences of climatic extremes particularly at critical crop growth stages may reduce yield significantly (Peng *et al.*, 1996). Transitory or constantly high temperatures cause an array of morph anatomical, physiological and biochemical changes in plants, which affect plant growth and development and may lead to a drastic reduction in economic yield (Wahid *et al.*, 2007). High temperature had a negative effect on the photosynthetic processes. There is clear evidence that thylakoid membranes can affect plant tolerance to high temperature and this can affect overall plant tolerance.

Although the effects of projected climate change on crop yields have been evaluated by using crop-simulation models, there are few studies on the effects of observed climate change on crop growth and yield (Peng *et al.*, 2004). The challenge is to understand crop responses to the differential increase in day versus night temperature on growth, yield and quality of rice so that crop management systems can be devised for high and sustainable yield in the era of global climate change. Having described the detrimental impact of climate change and asymmetric change in temperature and keeping all the above challenges in view, a study was undertaken on differential effect of increase in night versus day temperature on growth of wheat.

MATERIALS AND METHODS

The wheat crop was raised on during the second week of November 2006 by line sowing in the plastic container. After the seedling emergence. thinning operation was carried out so as to have hundred seedlings per container. Each variety was grown in twenty four containers comprising four treatments with six containers each. Following the establishment of wheat seedlings, the plants were subjected to high day and night temperature treatments by using the portable transparent polythene chamber.

The various temperature treatments were normal ambient temperature through out the growing season (T_0), high day and night temperature condition (HDNT) (T_1), high day temperature condition (HDNT) (T_2), and high night temperature condition (HDNT) (T_3).

The wheat plants of cultivars UP 2333 and PBW 343 were subjected to high temperature during daytime, night time and throughout day and night as per the requirements of thermal treatment mentioned above. The plants were covered with portable transparent polythene chamber during day. night and throughout day and night so as to provide the growth conditions accordingly. The plants at normal ambient temperature through out the growing season were taken as control (T_0). The plants at T_0 were not covered with portable transparent polythene chamber. The cultural practices like weeding, irrigation, fertilizer scheduling and crop pest control was practiced uniformly irrespective of the treatments. The polythene sheets of the portable transparent polythene chamber were washed frequently with water to allow the maximum light intensity to pass through the polythene sheets. The observations on growth parameters were taken at flowering and maturity stage.

RESULTS AND DISCUSSTION

Effect of high temperature on growth and development

Growth characters

Differential high day and night temperature caused marked increase in the stature of plants by enhancing the length of culm and leaf in both the varieties (Table 1). Length of the culm was increased due to the elongation of internodes. This result is in agreement with the study of Singh *et al.*, (2001). The higher day and night temperature treatment greatly reduced the tiller production and their development (Table 2). The reduced number of tillers is due to increased mortality of tillers occurring due to the intense competition for the limited resources (Hay, 1999). The tillers have to compete for the resources (assimilates and nitrogen) from elongating stems in the back drop of shorter crop growth duration and greater growth and maintenance of respiration which reduces biomass production under high temperature stress environment. The tillers begin to die in the reverse order of their initiation. So, the different high day and night temperature treatment condition causes change in the tillers. The number of tillers produced was greatly reduced under high day and night temperature and the deleterious effect was pronounced in PBW 343 indicating the thermal sensitivity of the variety. The reduction in biomass production due to high temperature condition also reduced the productive tiller percentage in heat stressed plants. Tillers are important contributors to final grain yield under heat-stress conditions.

The increase in leaf length of high temperature treated plants resulted in greater leaf area per shoot and leaf area per pot (Table 1). However, the leaf width showed no

Table 1. Effect of diferential night and day temperatures on growth of wheat varieties at flowering stage

Variety	Plant Height (cm)	Dry weight (g)			Leaf			Leaf area (cm^2)		Specific leaf area (cm^2/g)	Specific leaf weight (mg/ cm^2)	Days to flowerring
		Stem	Leaf	Total	Length	Width	LL/ LW	Per shoot	Per pot			
					UP 2338							
T_0	75.0	158.0	95.0	253.0	17.7	1.1	16.3	74.1	9781.4	101.1	10.4	102.0
T_1	81.3	130.0	80.0	210.0	22.2	1.2	18.9	98.3	10463.2	128.8	8.0	94.3
	(84)	(-17.7)	(-15.8)	(-17.0)	(-25.4)	(6.4)	(16.5)	(32.6)	(7.0)	(27.4)	(-23.3)	(-7.5)
T_2	80.0	141.0	87.0	228.0	21.3	1.1	18.8	90.4	10088.9	112.8	9.0	97.3
	(6.7)	(-10.8)	(-8.4)	(-9.9)	(20.1)	(2.7)	(15.9)	(22.0)	(3.1)	(11.6)	(-12.9)	(-4.6)
T_3	78.0	150.0	92.0	242.0	20.5	1.2	17.8	88.8	99938.2	108.9	9.2	98.7
	(4.0)	(-5.1)	(-3.2)	(-4.3)	(15.6)	(4.5)	(9.7)	(19.8)	(1.6)	(7.7)	(-11.1)	(-3.3)
					PBW 343							
T_0	76.0	148.0	109.0	257.0	18.0	1.3	13.5	90.0	13049.7	118.9	8.5	100.3
T_1	83.3	119.0	81.0	200.0	26.5	1.1	24.5	132.1	14868.8	180.7	5.7	92.0
	(9.6)	(-19.6)	(-25.7)	(-22.2)	(47.2)	(-17.3)	(80.6)	(46.7)	(13.9)	(52.0)	(-32.6)	(-8.3)
T_2	80.0	128.0	91.0	219.0	23.5	1.2	19.2	119.4	13924.9	149.6	6.7	95.7
	(5.3)	(-13.5)	(-16.5)	(-14.8)	(30.6)	(-7.5)	(41.5)	(32.6)	(6.7)	(25.8)	(-21.0)	(-4.7)
T_3	79.3	141.0	98.0	239.0	21.6	1.3	17.0	114.7	13657.2	141.9	7.0	97.7
	(4.4)	(-4.7)	(-10.1)	(-7.0)	(20.0)	(-2.3)	(25.8)	(27.4)	(4.7)	(19.4)	(-16.9)	(-2.7)
					CD at 5%							
V	NS	10.8	NS	NS	1.5	NS	NS	16.4	2628.4	18.1	1.2	1.1
T	4.6	15.3	12.9	27.9	2.1	NS	2.7	23.2	NS	25.5	1.7	1.6

Value in the parentheses indicate percentage deviation from control (T_0)

T_0-(Control) Normal ambient temperature

T_1-High temperature throughout day and night

T_2-High temperature only during daytime

T_3-High temperature only during nightmare

significant response to high day and night temperature. However, the increase in the leaf area and plant height did not increase the biomass production The biomass was reduced due to increase in dark and photorespiration under high temperature condition. At flowering stage, (Table 1), the plants subjected to different high day and night temperature showed greater specific leaf area due to decreased leaf thickness. The decrease in leaf thickness caused the specific leaf weight to decrease under high temperature conditions.

High day and night temperature stress affected the crop phenology by reducing days to flowering and days to maturity. The post-anthesis dry matter production was reduced under hyper thermal stress due to reduction in days to maturity and crop duration, increased leaf senescence and high degree of photosynthates loss through dark respiration and photorespiration. However, the pre-anthesis dry matter production was increased under high temperature stress condition and pre-anthesis dry matter production acts as buffer in the stress condition by providing assimilates to grain growth and development.

Table 2. **Effect differential in night and day temperatures on growth of wheat varieties at maturity stage**

Variety	No. of Tillers/pot	Productive tiller (%)	Dry weight (G)				DMP (%)		Photosynthetic		Days to maturity
			Stem	Leaf	Spike	Total	Pre-Anthesis	Post anthesis	Current	Reserve	
					UP 2338						
T_0	130.0	84.6	106.0	79.3	178.0	363.0	56.0	44.0	61.9	38.1	142.0
T_1	105.0	80.6	90.0	62.0	128.7	280.7	66.2	33.8	55.1	44.9	131.3
	(-19.2)	(-4.4)	(-15.1)	(-21.8)	(-27.7)	(-22.7)	(18.2)	(-23.1)	(-11.0)	(17.8)	(-7.5)
T_2	109.0	81.6	100.0	74.0	137.7	311.7	63.6	36.4	59.4	40.6	135.0
	(-16.2)	(-3.5)	(-5.7)	(-6.7)	(-22.7)	(-14.1)	(13.6)	(-17.3)	(-4.0)	(6.5)	(-4.5)
T_3	113.0	82.3	103.0	76.0	155.3	334.3	61.6	38.4	60.2	39.8	135.7
	(-13.1)	(-2.7)	(-2.8)	(-4.2)	(-12.7)	(-7.9)	(9.9)	(-12.6)	(-2.7)	(4.3)	(-4.5)
					PBW 343						
T_0	144.0	86.1	98.0	76.0	206.0	380.0	52.0	48.0	64.0	36.0	140.3
T_1	111.0	81.9	89.0	69.0	118.0	276.0	62.0	38.0	55.9	44.1	130.3
	(-22.9)	(-4.8)	(-9.2)	(-9.2)	(-42.7)	(-27.4)	(19.2)	(-20.8)	(-12.6)	(22.4)	(-7.1)
T_2	114.0	82.4	91.7	70.7	145.3	307.7	59.6	40.4	57.7	42.3	133.7
	(-20.8)	(-4.2)	(-6.5)	(-7.0)	(-29.4)	(-19.0)	(14.5)	(-15.8)	(-9.9)	(17.6)	(-4.6)
T_3	121.0	83.4	93.7	73.0	171.0	337.7	58.3	41.7	60.8	39.2	134.7
	(-16.0)	(-3.1)	(-4.4)	(-3.9)	(-17.0)	(-11.1)	(12.1)	(-13.1)	(-5.0)	(8.8)	(-4.0)
					CD at 5%						
V	7.6	1.1	4.1	NS	7.6	NS	3.8	3.8	NS	NS	NS
T	10.7	1.6	5.8	7.0	10.8	34.6	5.4	5.4	5.1	5.1	2.2

Value in the parentheses indicate percentage deviation from control (T_0)

T_0-(Control) Normal ambient temperature

T_1-High temperature throughout day and night

T_2-High temperature only during daytime

T_3-High temperature only during nightmare

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EFFECT OF MICRONUTRIENTS IN COMBINATIONS WITH ORGANIC MANURES ON PRODUCTION AND NET RETURNS OF SESAME (*SESAMUM INDICUM*) IN BUNDELKHAND TRACT OF UTTAR PRADESH

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ABSTRACT

A field experiment were conducted during *kharif* season of 2005 and 2006 to study the effect of micronutrients in combination with organic manures on production of sesame at C.S. Azad University of Agriculture and Technology Crop Research Farm, Mauranipur, Jhansi. Two organic manures viz., farmyard manure (2.5 tonnes/ha) and need cake (0.5 ton/ha), and two micronutrients viz., zinc sulphate (20 kg/ha) and ferrous sulphate (25 kg/ha) were added with full recommended dose of fertilizer (40:20:20:30 kg NPKS/ha). The pooled results revealed that the treatments applied with 100% of the recommended NPKS fertilizer along with micronutrients and organic manure recorded significantly higher growth and yield attributing characters, seed yield and net returns over half of the recommended dose of fertilizer (20:10:10:15 kg NPKS/ha) coupled with micronutrients and organic manure. Combined use of zinc sulphate and ferrous sulphate along with farmyard manure mixed with 100% recommended dose of fertilizer exhibited a pronounced effect on the growth characters viz., number of branches/plant and dry weight/plant, and yield attributes viz., number of capsules/plant, seed weight/plant and test weight, The seed yield and net returns were significantly influenced by the same treatment, which resulted 29.7 and 37.2% increase, respectively, over 100% recommended NPKS fertilizer alone. The same treatment also registered the highest net return/rupee of investment (Rs 1 .85). The individual application of zinc and iron along with farmyard manure ranked next places in all respects. Among the treatments having only organic manures with chemical fertilizers, the over all performance of farmyard manure was the best.

Key words : *Sesamum indicum*, zinc sulphate, ferrous sulphate, yield attributes, seed yield, net returns.

Sesame (*Sesamurn indicum* L.) is the ancient oilseed crop cultivated in most of the states of India. This crop is cultivated almost throughout India for its high quality oil and it has tremendous potential for export. It ranks third and fourth in terms of total oilseed area and production in the country, respectively, it is graining considerable importance on account of its high economic value as edible oil. The average productivity of this crop in India is very low (335 kg/ha) as compared to Venejuela (1960 kg/ha) (Shanker *et al.*, 1999). Poor soil fertility especially micronutrients, organic carbon etc. are limiting the growth and yield of sesame crop. Integrated use of organic and inorganic fertilizers may sustain productivity by improving soil physical conditions (Singh *et al.*, 1990). Among the micronutrients, zinc has been found to increase the yield considerably (Prakash, 1998). However, the farmyard manure plays an important role in conserving soil moisture and improving soil texture and structure. It also sustains fertility status of soil. Neem cake is also rich source of nitrogen, phosphorous and potash and it has smothering effect for controlling weeds. Hence, an attempt was made to find out the effect of micronutrients along with organic manures on growth and yield of sesame under rain fed condition in Uttar Pradesh.

MATERIALS AND MATHODS

A field experiment was conducted at C.S. Azad University of Agriculture & Technology Crop Research Farm, Mauranipur, Jhansi during two consecutive kharif seasons of 2005 and 2006. The soil of experimental field was sandy clay, with pH 7.5, low in organic carbon (0.20%) and available nitrogen (228 kg/ha), medium in available phosphorous (10.8 kg/ha), high in available potassium (255 kg/ha) and medium in available sulphur (15.8 kg/ha). The rainfall was 304 mm and 349 mm during the crop season of 2005 and 2006, respectively. The experiment consisted of 12 treatments (Table 1) were laid out in randomized block design with three replications. Sesame variety 'T-78' was sown in rows of 30 cm apart adopting a seed rate of 5 kg/ha on July 13 and 14 during 2005 and 2006, respectively. Well- decomposed farmyard manure was incorporated in the respective treatments 15 days before sowing of sesame crop. Half the dose of nitrogen and full the dose of phosphorous, potassium, sulphur, zinc sulphate and ferrous sulphate were applied at the time of sowing. Remaining half the dose of nitrogen was applied at 30 days after sowing, whenever rainfall is received. Recommended agronomic practices were followed for raising the crop. The data on growth and yield attributes as well as seed yield were recorded at harvest and same were pooled. Economics was worked out by estimating the cost incurred and yields obtained from different treatments.

RESULTS AND DISCUSSION

Growth and yield attributes

Application of either zinc or iron alone or in combination with organic manures has resulted in increased all the growth and yield attributing characters (Table 1). The pooled results revealed that the treatments applied with 100% of the recommended fertilizer (40:20:20:30 kg NPKS/ha) along with either of micronutrients along with farmyard manure recorded significantly highest number o branches plant dry-matter production more number of capsules /plant, seed weight/plant and test weight, maximum seed yield and maximum net returns over these applied with half of the recommended dose of fertilizer (20:10:10:15 kg NPKS/ha). The addition of organic manures in these treatments and their subsequent decomposition in soil released the plant nutrients slowly throughout the crop growth and thus, improved all the growth and yield attributes of the crop. Similar findings were also reported by Duhoon et al. (2001). Combined application of zinc sulphate (20 kg/ha), ferrous sulphate (25 kg/ha) and farmyard manure (2.5 tonnes/ha) with 100% recommended dose of fertilizer (40:20:20:30 kg NPKS/ha) treatment recorded the maximum number of branches/plant (4.45) and more dry-matter production (3560 kg/ha) as compared to 3.20 and 2765 kg/ha, respectively in control (100% RDF alone) representing 39.06 and 28.75% increase over control. The individual application of zinc sulphate (20 kg/ha) and ferrous sulphate (25 kg/ha) in soil with 100% chemical fertilizer produced 3.95 and 3.75 branches/plant and dry-matter production of 3292 and 3122 kg/ha, respectively. The increased plant growth characters with application of micronutrient were reported by Tiwari et al. (1995) and Singaravel *et al.* (2001). The lowest number of branches/plant (3.20) and dry-matter production (2765 kg/ha) were observed in application of 100% recommended dose of fertilizer alone plot.

Likewise, the combined application of zinc sulphate and ferrous sulphate in soil also excelled all the other treatments and had produced, on an average, the highest number of capsules/plant (53.35), seed weight/plant (5.65 g) and test weight (3.75 g). The beneficial effect of micronutrients on the yield attributes of sesame crop might be due to activation of various enzymes and efficient utilization of applied nutrients, especially nitrogen and phosphorus, resulting in increased yield components as reported by Shanker *et al.* (1999) and Singaravel *et al.* (2001). The lowest yield attributes were under the application of recommended NPKS fertilizer alone plots.

Seed yield

The application of 50 or 100% of recommended dose of fertilizer applied either with organic manures alone or in combination with micronutrients gave significantly higher seed yield over sole application of 50 or 100% of recommended fertilizer (Table 1). The crop fertilized with recommended NPKS fertilizer combined with farmyard manure gave higher

Table 1. Effect of micronutrients and organic manures in combination with inorganic fertilizers on growth and yield attributing characters of sesame

Treatment	Growth attributes						Yield attributes								
	Branches/plant			Dry weight/ plant (kg/ha)			Capsules/plant			Seed weight/plant (g)			1000-seed weight (g)		
	2005	2006	mean	2005	2006	mean	2005	2006	mean	2005	2006	mean	2005	2006	mean
T_1	3.10	3.30	3.20	2638	2892	2765	42.30	44.20	43.25	4.70	4.90	4.80	2.40	2.50	2.45
T_2	2.40	2.60	2.50	1929	1977	1953	34.30	36.30	35.30	3.80	4.00	3.90	2.30	2.40	2.35
T_3	3.40	3.70	3.55	2805	3175	2990	47.20	48.30	47.75	5.00	5.20	5.10	2.60	2.90	2.75
T_4	2.40	2.80	2.60	2090	2158	2124	36.20	38.30	37.20	4.30	4.40	4.35	2.50	2.60	2.55
T_5	3.30	3.70	3.50	2769	3005	2887	45.30	47.20	46.25	4.90	5.00	4.95	2.60	2.70	2.65
T_6	2.50	2.90	2.70	1985	2139	2062	35.20	37.20	36.20	4.50	5.60	4.55	2.40	2.45	2.43
T_7	3.80	4.10	3.95	3048	3536	3292	50.60	52.10	51.35	5.30	5.60	5.45	3.40	3.60	2.35
T_8	2.60	2.90	2.75	2344	2462	2403	39.40	41.60	40.50	4.50	4.70	4.60	2.90	3.00	2.95
T_9	3.60	3.90	3.75	2935	3309	3122	49.00	49.30	49.15	4.60	5.80	5.20	3.15	3.35	3.25
T_{10}	2.60	3.00	2.80	2305	2375	2340	38.20	40.30	39.25	4.40	4.60	4.50	2.70	2.80	2.70
T_{11}	4.30	4.60	4.45	3387	3733	3560	52.30	54.40	53.35	5.40	5.90	5.65	3.60	3.90	3.75
T_{12}	2.70	3.10	2.90	2497	2603	2550	40.30	42.30	41.30	4.60	4.80	4.70	3.20	3.35	3.28
SE±	0.22	0.25	0.19	108	132	96	2.20	2.45	2.00	0.30	0.35	0.27	0.18	0.21	0.15
CD (P=0.05)	0.45	0.52	0.38	218	270	194	4.45	4.95	4.05	0.62	0.69	0.55	0.37	0.43	0.31

T_1, 100% Recommended dose of fertilizer (RDF i.e. 40:20:20:30 kg NPKS/ha); T_2, 50% RDF (20:10:10:15 kg NPKS/ha); T_3, 100% RDF + 2.5 t farmyard manure (FYM)/ha: T_4, 50% RDF + 2.5 t FYM/ha; T_5, 100% RDF + 0.5 t neem cake/ha; T_6, 50% RDF + 0.5 t neem cake/ha; T_7, 100% RDF + 2.5 t FYM/ha + 20 kg/ha $ZnSO_4$; T_8, 50% RDF + 2.5 t FYM/ha + 20 kg/ha $ZnSO_4$; T_9, 100% RDF + 2.5 t FYM/ha + 25 kg/ha $FeSO_4$; T_{10}, 50% RDF + 2.5 t FYM/ha + 25 kg/ha $FeSO_4$; T_{11}, 100% RDF + 2.5 t FYM/ha + 20 kg/ha $ZnSO_4$ + 25 kg/ha $FeSO_4$; T_{12}, 50% RDF + 2.5 t FYM/ha + 20 kg/ha $ZnSO_4$ + 25 kg/ha $FeSO_4$

Table 2. Seed yield oil yield and economics of sesame as influenced by micronutrients and organic manures in combination with inorganic fertizer

Treatment	Seed yield (kg/ha)			Net return (Rs/ha)			Net return/rupee		
	2005	2006	mean	2005	2006	mean	2005	2006	mean
T_1	666	720	693	11977	13597	12787	1.49	1.69	1.59
T_2	492	501	497	7158	7427	7293	0.94	0.97	0.95
T_3	710	822	766	12795	16155	14475	1.50	1.89	1.69
T_4	530	564	547	7796	8816	8306	0.96	1.08	1.02
T_5	699	780	740	10467	12897	11682	0.99	1.22	1.10
T_6	532	594	563	5858	7718	6788	0.57	0.76	0.66
T_7	781	892	837	14526	17856	16206	1.63	2.00	1.81
T_8	612	638	625	9857	10637	10247	1.15	1.25	1.20
T_9	744	859	800	13292	16742	15032	1.47	1.85	1.65
T_{10}	588	604	596	9013	9493	9253	1.04	1.10	1.07
T_{11}	840	958	899	15774	19314	17544	1.67	2.04	1.85
T_{12}	636	678	657	10055	11315	10685	1.11	1.25	1.18
SE±	38	25	21	926	781	776	0.12	0.08	0.06
CD (P=0.05)	74	52	45	1864	1582	1565	0.25	0.17	0.13

T_1, 100% Recommended dose of fertilizer (RDF i.e. 40:20:20:30 kg NPKS/ha); T_2, 50% RDF (20:10:10:15 kg NPKS/ha); T_3, 100% RDF + 2.5 t farmyard manure (FYM)/ha; T_4, 50% RDF + 2.5 t FYM/ha; T_5, 100% RDF + 0.5 t neem cake/ha; T_6, 50% RDF + 0.5 t neem cake/ha; T_7, 100% RDF + 2.5 t FYM/ha + 20 kg/ha $ZnSO_4$; T_8, 50% RDF + 2.5 t FYM/ha + 20 kg/ha $ZnSO_4$; T_9, 100% RDF + 2.5 t FYM/ha + 25 kg/ha $FeSO_4$; T_{10}, 50% RDF + 2.5 t FYM/ha + 25 kg/ha $FeSO_4$; T_{11}, 100% RDF + 2.5 t FYM/ha + 20 kg/ha $ZnSO_4$ + 25 kg/ha $FeSO_4$; T_{12}, 50% RDF + 2.5 t FYM/ha + 20 kg/ha $ZnSO_4$ + 25 kg/ha $FeSO_4$

seed yield than that of recommended dose of fertilizers + neem cake (0.5 t/ha) treatment at both levels of chemical fertilizers *viz.*, 50 and 100%. Tiwari *et al.* (1995) also reported similar synergetic effect of farmyard manure with inorganic fertilizers in sesame crop.

The combined application of zinc sulphate and ferrous sulphate along with farmyard manure mixed with 100% chemical fertilizer treatment also established its superiority over all other treatments and recorded, on an average, the highest seed yield of 899 kg/ha in comparison to 693 kg/ha in control. This represented a percentage increase of 29.7 over control (100% inorganic fertilizer alone treatment). The application of zinc and iron alone increased the yield in the range of 802 to 837 kg/ha. The extent of seed yield increase under these treatments was 20.8 and 15.7% over 100% recommended dose of fertilizer alone, respectively. This may be due to positive and cumulative effect of farmyard manure and micronutrients resulting in higher number of branches/plant, more dry-matter production, number of capsules/plant, seed weight/plant and 1000-seed weight. The application of 100% N1KS fertilizer in combination with farmyard manure and ferrous sulphate recorded on par seed yield (802 kg/ha) than 100% recommended doe of fertilizer + FYM alone treatment (766 kg/ha). The lowest seed yield was obtained under sole application of recommended dose of fertilizer treatments. The present results are in conformity with the earlier finding of Singaravel *et al.* (2001) and Thiruppathi *et al.* (2003).

Net returns

The net returns were influenced significantly due to addition of farmyard manure and micronutrients with chemical fertilizers (Table 1). Pooled results revealed that combined application of zinc sulphate and ferrous sulphate along with farmyard manure resulted in significantly higher net returns of Rs. I 7544/ha than full recommended dose of fertilizer applied either alone or in combination with organic manures. This treatment also obtained at par net returns of Rs. 16206/ha to that of application of zinc sulphate alone treatment. The same treatment registered the highest net return/rupee invested of Rs. 1 .85, closely followed by application of zinc sulphate (Rs. 1.81) and ferrous sulphate (1.65) alone treatments. The individual application of zinc sulphate and ferrous sulphate along with FYM and 1 00% chemical fertilizer also fetched significantly higher net, returns by the margin of Rs. 3419 and 2245/ha over control. The application of 100% NPKS fertilizer along with FYM and ferrous sulphate recorded on par net returns and net return/rupee of investment than 100% recommended dose of fertilizer + FYM alone treatment. This was mainly owing to higher economic production in these treatments. The application of recommended dose of fertilizer along with neem cake in both cases *viz.*, 50 and 100% recorded the least net returns of Rs. 6788 and Rs. 11682/ha and net return/rupee invested of Rs. 0.66 and Rs. 1.10, respectively.

Thus, it can be concluded that addition of farmyard manure, zinc sulphate and ferrous sulphate together with recommended NPKS fertilizer was beneficial in increasing growth characters, yield attributes, seed yield and net returns in sesame crop.

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EFFECT OF FOLIAR APPLICATION OF METHANOL ON GROWTH AND LEAF YIELD IN MULBERRY (*MORUS ALBA* L.)

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Abstract

An experiment was conducted at Central Sericultural Research and Training Institute, Berhampore (West Bengal) during 2006-2007 to find the effect of methanol on growth, leaf yield and quality of mulberry. The mulberry plants were sprayed with methanol in 3 different concentrations. First foliar spray was given after 15 days of pruning on newly emerged leaves while second spray was done after 30 days of pruning. Significant positive influence of aqueous methanol (5,10 &15 percent) on improved mulberry varieties viz, S-1635 and S-1 was observed in most of the yield attributing parameters. Application of methanol significantly increased number of leaves per plant and leaf dry and fresh weight in both the cultivars significantly at all the 3 concentrations.

Key words : Leaf moisture, leaf area, leaf yield, mulberry, photosynthesis.

Foliar application of plant growth substances is one of the quicker techniques for improvement of leaf productivity. Plants can effectively up take nutrition when applied as foliar fertilizer sprays. Several studies were done with foliar spray of growth hormones in different vegetables and cash crops.

In sericulture, although winter season (autumn & spring) are congenial for silkworm rearing but it is adverse for leaf production due to fluctuation of climatic condition as well as low temperature and low humidity, sometimes with foggy weather and prone to severe disease incidences. This causes a serious problem to the sericulturists and the farmers. Therefore, the farmers are forced to reduce the brushing quantum or chawki (young age) silkworm larvae also. Hence the income also becomes restricted. The application of growth hormones, particularly NAA and Triacontanol base plant growth regulator (PGR) significantly increased the leaf yield of mulberry and its quality mainly during dry winter season (Setua *et al.*, 1996 and 1998).

Number of researchers have also observed that aliphatic alcohols improved the productivity and quality of various crops (Malik, 1993, Setia *et al.*, 1993, Sharma and Malik , 1994) as well as increased the photosynthetic rate (Thind *et al.*, 1996). The plants use methanol as a source of carbon. The effect of methanol on growth in some crops like cotton, lettuce and tomato were found excellent than any other foliar nutrient (Lee Dye, 1993, Guvenc and Kaymak, 2006). Nonomuro and Benson (1992) reported that foliar spray of methanol under temperate and arid field conditions increased vegetative growth. Methanol also increased yield and vegetative growth of different vegetable crops (Albrecht *et al.*, 1995). Kumar *et al.* (1999) studied effect of foliar spray of methanol on cotton. However, there was no report available on the effect of foliar spray of methanol on Mulberry. Therefore, an experiment was conducted to study the effect of foliar spray of Methanol on mulberry plant during later part of dry winter season (February -March).

Materials and Methods

The study was undertaken at Central Sericultural Research and Training Institute, Berhampore, West Bengal for 2 years (2006 and 2007) during dry winter season (March) with one-year-old potted plants of two improved mulberry varieties (S-1635 and S-1) in Gangetic alluvial soil. The experiment was laid out in completely randomized block design with six replications with one plant in each pot (totally six plants). Three concentrations of methanol (5, 10 &15 %) along with water spray as control were the four treatments in total. The spray was done during the morning hours (9 am) by hand sprayer. First spray was given on the newly emerged leaves after 15 days of pruning while second spray was done after 30 days of pruning. Standard cultural operations were followed as per the package of practices recommended for irrigated garden (Ray *et al.*, 1973). Photosynthesis was measured from top 5th to 7th expanding leaf with Licor - 6200 photosynthetic meter, while Leaf moisture was measured by Mettler moisture meter and leaf area by leaf area meter. Data on morphological parameters and leaf yield were recorded from six replications after 60 days of pruning. Average of six replications for one season in each of two years were presented in table after statistical analysis.

RESULTS AND DISCUSSION

Foliar application of methanol significantly increased plant height, leaf number / plant and leaf yield among the treatments. Plant height and total number of leaves /plant were significantly increased in S-1 with all the 3 concentrations of methanol over control. While 10% and 5% methanol significantly increased plant height and leaf number /plant in S-1635. Although the leaf yield/plant was maximum with foliar spray of 5% methanol on both S-1635 (350g/plant) and S-1 (383.3g/plant) mulberry varieties, but it was not significantly higher with control in case of S-1635, while it was significantly increased in S-1 over control. Increase in leaf yield was observed as 16 % in S-1635 and 36% in S-1 over control. Leaf area was increased in S-1635 at all 3 levels of methanol (Table 1). Photosynthesis was increased in S-1635 at all the 3 levels of methanol and was significantly increased with 5 and 10% methanol spray in S-1635, while in S-1 it was increased only in 5% methanol. Leaf moisture of mulberry is an important parameter considered for silkworm rearing. In the experiment leaf moisture was increased by 5% methanol in S-1635 (84.4%) mulberry variety (Table 2). Overall among the traits tested, the cultivars S-1635 appears to be superior in respect to many of the parameters over S-1. The study also indicated the influence of aliphatic alcohols in stimulating the photosynthesis leading to increase in leaf yield. This corroborates the findings of Lee Dye

Table 1. Effect of foliar spray of methanol on growth and leaf yield in mulberry varieties

Treatment	Plant height (cm)		Leaf No. plant		Branch No./plant		Leaf yield (g/plant)		Leaf area (cm²)	
	S-1635	S-1	S-1635	S-1	S-1635	S-1	S-1635	S-1	S-1635	S-1
5%	92.66	91.66	183.6	315.0	10.66	10.70	350.0	383.0	132.5	46.43
10%	99.33	85.66	162.0	271.0	8.33	8.50	327.6	313.3	134.4	58.6
15%	96.33	85.90	155.0	259.0	7.33	10.16	291.0	261.0	119.36	49.3
Control	85.33	64.58	153.0	154.0	8.66	8.66	300.0	281.0	95.36	46.0
CD at 5%	11.54		52.2		NS		52.19		14.04	

Table 2. Effect of foliar spray of methanol on photosynthesis and leaf moisture in mulberry varieties

Treatment	Photosynthesis (m mol/m²/s¹)		Fresh weight of 100 leaves (g)		Dry weight of 100 leaves (g)		Leaf moisture (%)	
	S-1635	S-1	S-1635	S-1	S-1635	S-1	S-1635	S-1
5%	12.48	11.41	99.0	61.0	19.0	14.3	84.4	76.5
10%	12.87	10.52	104.6	73.0	23.3	17.6	77.7	75.8
15%	10.13	9.51	94.6	60.3	18.4	14.3	80.5	76.3
Control	10.29	10.28	89.5	50.3	13.9	12.0	80.8	76.1
CD at 5%	0.446		0.524		0.23		0.917	

(1993), Guvenc and Kaymak. (2006) and Kumar *et al.* (1999). Thus foliar application of methanol at 5% concentration can be used and recommended for increasing the growth parameters and mulberry leaf yield both in S-1635 and S-1 mulberry varieties in general and S-1 in particular in respect of leaf yield especially during dry winter seasons.

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INTEGRATED NUTRIENT MANAGEMENT IN WHEAT (*TRITICUM AESTIVUM*) AND IT'S RESIDUAL EFFECT ON RICE (*ORYZA SATIVA*) IN NORTH-WESTERN HIMALAYAS

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ABSTRACT

A field experiment was conducted during 2001-02 to 2003-04 at CSK HP Krishi Vishvavidyalaya, Palampur, to study the effect of organic sources and fertility levels on wheat and their residual effect on rice. Five organic sources, *viz.* S_1 : FYM 5.0 t/ha on dry weight basis, S_2: paddy straw, S_3 : soybean straw, S_4: FYM 2.5 t/ha + paddy straw and S5 : FYM 2.5 t/ha + soybean straw (paddy and soybean straw were applied to supply N as in Si) were applied in all possible combinations with 3 fertility levels *viz.* 50, 100 (120 kg N + 26.2 kg P + 24.5 kg K/ha) and 150% of recommended fertilizer dose (RDF) to wheat crop. Sixteen treatments including one absolute control (no fertilizer and manure) were laid out in randomized block design with 3 replications. Organic sources and fertility levels significantly affected the plant height, yield attributes and productivity of wheat crop. Averaged over the fertility levels, S_1 produced significantly higher wheat grain yield (41.7 q/ha) followed by S_4 (31.6 q/ha), S_5 (31.4 q/ha), S_2 (28.5q/ha) and S_3 (28.4 q/ha). Growth (plant height) and yield attributes viz, effective tillers per m row length, number of grains per spike and 1000 - grain weight supported the productivity levels. Based on the mean value of three years, gross return (Rs 37,294/ha), net return (Rs 18,184/ha) and benefit: cost ratio from wheat was higher in S_1. Application of 100 and 150% of recommended dose of chemical fertilizers compared to 50% level increased wheat productivity by 5.3 (19.6%) and 10.7 (39.5%) q/ha, respectively. On an average, wheat productivity increased by 126.9 per cent with integrated nutrient management compared to absolute control (no manure/fertilizes).Residual effect of fertility levels applied to wheat improved the growth, yield parameters (number of tillers per unit area and 1000 grain weight) and paddy yield significantly up to 100% level where as residual effect of organic sources was not significant. Thus, high productivity (41.7 q/ha) and profitability of the wheat (in wheat - rice system) can be realized by applying FYM 5 t/ha alongwith 150% of recommended dose of chemical fertilizers. However, FYM 2.5 t/ha + paddy/soybean straws may also be used to obtain comparatively lower productivity levels (31.4-31.6 q/ha).

Key words: Integrated nutrient management, productivity, profitability, wheat-rice system.

Rice (*Oryza sativa* L.) - wheat (*Triticum aestivum* L. emend. Fiori & Paol.) is the major cropping system in India covering about 10 - 12 million hectares of area and contributing approximately 22% to the total food grain production. This system is equally important in Himachal Pradesh too. There are indications of stagnation or even decline in the productivity of such exhaustive cropping systems due to decline in soil organic matter, over mining of nutrient reserves, losses of nutrients and non- availability of cost effective fertilizers as clearly evolved through long-term fertilizer experiments being conducted in different parts of the country. Further, application of inorganic fertilizers even in balanced form may not sustain soil fertility and productivity under continuous cropping (Subba Rao and Srivastava, 1998). However, integrated use of inorganic and organics including crop residues may improve the soil productivity (Patra *et al.*, 2000; Sharma and Kaur, 2003; Chettri and Bandhopadhaya, 2005, Mankotia., 2007).Moreover, the hill soils being rich in clay content respond to organic matter addition very well (Mankotia and Sharma, 1997) may be due to the improved physical soil conditions. Growing legume green manures is not possible in hills between harvest of wheat and transplanting of rice due to inadequate duration and large dependence on rains. In this context, use of locally available low value crop residues appears to be an option to supplement crop nutrition. Therefore, present investigation was undertaken to evaluate the effect of organic sources and fertility levels on wheat and their residual effect on rice.

MATERIALS AND METHODS

A field experiment was conducted during 2001-02 to 2003-04 on Himalayan acid alfisols at CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (32°6'E 76°3N 1280 m above mean sea level, average annual rainfall 2,500 mm) to evaluate the effect of organic sources and fertility levels on wheat and their residual effect on rice. The zone is categorized as mid-hill sub humid zone. The soil of the experimental field was silty clay loam in texture, acidic (pH 5.7) in reaction, having available N 309.5 kg/ha. P 9.5 kg/ha, K 209.3 kg/ha and organic carbon 0.92%. Five organic sources, *viz.* S_1 : FYM 5.0 t/ha on dry weight basis, S_2 : Paddy straw, S_3 : Soybean straw, S_4: FYM 2.5 t/ha + paddy straw and S_5 : FYM 2.5 t/ha + soybean straw (paddy and soybean straw were applied to supply N as in S_1) were applied in all possible combinations with 3 fertility levels *viz.* 50, 100 (120 kg N + 26.2 kg P + 24.5 kg K/ha) and 150% of recommended fertilizer dose (RDF) to wheat crop. Sixteen treatments including one absolute control (no fertilizer and manure) were laid out in randomized block design with 3 replications. The dry matter quantities of different organic materials applied to supply N equal to that in S_1 are given in Table 1.

The crop residues were chopped and applied at the time of field preparation and incorporated into the soil. The nitrogen (Urea 46%) was applied in three splits (basal and two topdressings) and whole phosphorus (SSP 16%) and potassium (MOP 60%) were supplied as basal dose. Returns from the wheat cultivation were computed on the basis of prevailing market prices of inputs and outputs during the cropping season. N uptake by third wheat crop was also computed. The available soil NPK status after the harvest of third wheat crop was also monitored. To study the residual effect, if any, the transplanted rice crop was raised by applying 50% of recommended dose of nitrogen and potassium fertilizers. Absolute control did not receive any fertilizers during the rice season too.

RESULTS AND DISCUSSION

Direct effect of organic sources on wheat in wheat-rice system

Significant effect of organic sources and fertility levels was observed on the wheat crop during all the three years (Table 2). Averaged over the fertility levels. application of FYM 5 tonnes/ha (S_1) produced significantly higher grain yield (mean 41.7 q/ha) as compared to the incorporation of paddy or soybean straw singly or in combination with FYM 2.5 tonnes/ha in all the three years. The grain yield in S_4 (31.6 q/ha), S_5 (31.4 q/ha), S_2 (28.5q/ha) and S_3 (28.4 q/ha) was less. Growth (plant height) and yield attributes viz, effective tillers per meter row length, number of grains per spike and 1000-grain weight supported the productivity levels. On an average yield declined by one-fourth (24%) when FYM 2.5 tonnes/ha was substituted

Table 1. Quantities of organics added on dry weight basis under different treatments

Treatment	2001-02	2002-02	2003-04
S_1	FYM 5.0 t/ha	FYM 5.0 t/ha	FYM 5.0 t/ha
S_2	Paddy straw 4.6 t/ha	Paddy straw 5.0 1/ ha	Paddy straw 4.8 t/ ha
S_3	Soybean straw 2.6 t/ha	Soybean straw 2.8 t/ha	Soybean straw 2.7 t/ha
S_4	FYM 2.5 t/ha + paddy straw 2.3 t/ha	FYM 2.8 t /ha + paddy straw 2.5 t/ha	FYM2.5 t /ha + paddy straw 2.4 t/ha
S_5	FYM2.5t/ha+ soybean straw 1.3 t/ha	FYM2.5t/ha+ soybean straw 1.4 t/ha	FYM2.5t/ha+ soybean straw 1.35 t/ha

Table 2. Direct effect of organic sources and fertility levels on growth (plant height), yield attributes and yield of wheat

Treatment	High (cm)			Tillers/m row Length			Grains/spike			1000 gain weight (g)			Straw yield (q/ha)			Grain yield (q/ha)			Mean
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	
Organic sources																			
S_1	75	90	79	61	42	49	45	54	54	43.5	48.0	45.0	78.8	53.5	71.5	45.4	33.5	46.2	41.7
S_2	72	83	71	52	47	40	41	49	45	42.1	47.9	40.3	48.6	37.1	54.9	25.9	23.8	35.7	28.7
S_3	69	84	74	56	39	43	43	49	47	40.5	44.7	42.1	46.7	46.1	58.5	23.3	23.7	38.1	28.4
S_4	72	86	74	59	41	46	42	50	50	40.8	46.0	42.9	52.1	42.8	64.3	26.5	26.1	42.2	31.6
S_5	75	88	77	57	37	48	44	49	51	42.1	46.8	43.9	48.1	49.6	66.3	25.1	26.1	43.1	31.4
CD at 5%	5.4	NS	1.7	NS	1.8	1.3	NS	1.3	5.8	NS	1.9	1.3	10.7	8.2	1.4	4.97	4.90	1.70	
Fertility levels																			
50%	72	72	67	49	39	39	40	45	45	41.1	45.8	40.4	46.6	38.4	53.1	23.5	22.9	34.6	27.0
100%	73	91	78	58	43	47	44	52	50	42.3	47.3	43.3	50.8	47.3	66.2	28.6	26.9	41.4	32.3
150%	74	95	79	63	42	49	45	5.	53	41.9	46.9	44.8	67.1	51.8	69.9	35.5	30.2	47.3	37.7
CD at 5%	NS	4.6	1.3	5.7	1.4	1.0	2.8	1.0	4.5	NS	NS	1.0	46.2	6.3	1.1	..85	3.80	1.29	
Control vs others																			
Control	41	67	46	40	34	31	32	19	21	38.7	44.1	30.2	20.6	29.5	33.4	10.9	14.5	17.3	14.2
Others	73	86	75	57	41	45	43	50	50	41.8	46.7	42.8	54.8	45.8	63.1	29.2	26.6	41.1	32.3
CD at 5%	9.7	10.8	3.1	13.2	3.3	2.3	6.4	2.2	10.4	NS	0.4	2.4	28.9	14.7	2.5	8.89	8.80	2.97	

I : 2001-02, II : 2002-03, IIII : 2003-04

with paddy (S_4) or soybean (S_5) straw on equivalent N basis. The wheat crop responded well to FYM application as the experimental soil was medium in available N (309.5 kg/ha), K (209.3kg/ha) and organic carbon (0.92%) and was low in available P (9.5 kg/ha). The well rotten and decomposed farmyard manure might have supplied nitrogen and other macro and micro nutrients right from the seedling stage of the crop resulting in high yields in S. Contrarily, chopped paddy and soybean straws might have taken long time to decompose and supply the much needed nutrients yis a vis wider C:N ratio of these straws might have lead to immobilization of nitrogen and thus adversely affecting the nutrients to the germinating seedlings as compared to the farmyard manure. Results closely resemble to those of Singh and Paroda (1993). Singh and Chauhan (2002) and Chaudhary *et al.* (2006). N uptake (grain + straw) estimated for third wheat crop followed mainly the trend of grain and straw yields, hence, higher uptake was recorded in S_1 plots (Table 3). Based on the mean value of three years, gross return (Rs 37,294/ha), net return (Rs 18,184/ha) and benefit: cost ratio of wheat cultivation were higher with FYM 5 t/ha (S_1).

Direct effect of fertility levels on wheat in wheat-rice system

NPK play a vital role in the plant growth and development. Nitrogen is an integral part of different enzymes, proteins, chlorophyll, etc. which stimulate different biochemical events in the plants. P is an integral part of many constituents such as nucleoprotein, NAD, ATP and plays a key role in various energy transfer processes. It is essential for formation of root system which in turn increases uptake of water and nutrients which gives a rapid and vigorous start to plant. K, besides activating more than 60 enzymes, plays a key role in stomatal opening which increases the photosynthetic rate. In the present investigation too, averaged over the organics, increase in fertility level improved the growth (plant height), yield parameters and thereby increase in fertility level increased the wheat grain and straw yields significantly except the 100 and 150% levels during second year recorded statistically equal grain yield (Table 2). Application of 100 and 150% of recommended dose of chemical fertilizers compared to 50% level increased wheat productivity by 5.3 (19.6%) and 10.7 (39.5%) q/ha, respectively. Similar results have also been reported by Sharma and Sharma (1993), Praminick and Das (1997) and Chaudhary *et al.* (2006). N uptake (grain + straw) estimated for third wheat crop showed trend of seed and straw yields (Table 3). Thus application of 150% recommended fertility level recorded

Table 3. Economics of wheat cultivation, N uptake by third wheat crop, soil available N status after third wheat crop and residual effect on succeeding rice

Treatment	Returns (Rs/ha) Gross	Returns (Rs/ha) Net	B:C	N uptake (kg/ha)	Available soil N (kg/ha)	Paddy yield (q/ha) 2002	Paddy yield (q/ha) 2003	Paddy yield (q/ha) 2004
Organic sources								
S_1	37,297	18,184	0.95	123.5	331.8	26.7	26.6	27.4
S_2	25,532	11,923	0.88	94.0	321.2	24.8	25.2	24.8
S_3	26,002	12,393	0.91	100.1	327.0	25.6	25.8	25.4
S_4	28,500	12,890	0.93	111.7	330.1	25.5	25.8	254.0
S_5	28,631	13,021	0.83	114.2	328.8	24.8	25.1	26.8
CD at 5%				2.5	NS	NS	NS	NS
Fertility levels								
50%	24,451	10,471	0.76	83.0	318.7	23.1	23.2	23.2
100%	29,206	13,696	0.88	110.8	325.5	26.2	26.5	26.1
150%	33,919	16,879	0.99	124.8	339.8	27.2	27.4	28.3
CD at 5%				1.9	8.5	1.47	1.25	2.65
Control vs others								
Control	13,426	1,744	0.19	48.6	287.2	15.5	15.7	10.6
Others	29,192	13,682	0.88	108.7	327.8	25.5	25.7	25.9
CD at 5%				4.5	13.9	3.38	2.79	6.12

more N (124.8 kg/ha) uptake. Mean value of benefit: cost ratio and gross and net returns, exhibited increase with increase in fertility level and these values at 150% fertility level were 0.99, Rs 33,919/ha, and Rs 16,879/ha, respectively.

Residual effect on rice in wheat - rice cropping system

Rice-wheat crop was raised with only 50% of recommended dose of N and K to study the residual effect of organics and fertility levels applied to the previous wheat crop. The available soil N estimated after the harvest of third wheat crop revealed an improvement over the initial soil available N value by 8.8 to 27.7 kg N/ha with the use of different organic sources and fertility levels whereas decrease by 22.3 kg N/ha was observed in absolute control (Table 4). The available soil N did not register significant variation due to organic sources whereas it showed increase with increase in fertility level. Residual effect of fertility levels applied to wheat improved the growth, yield parameters (number of tillers per unit area and 1000 grain weight) and productivity of rice crop (Tables 3 and 4); rice productivity at 100 and 150% level was statistically equal in all the three years. The rice productivity did not vary significantly due to the residual effect of organic sources.

Thus, high productivity (41.7 q/ha) and profitability of the wheat (in wheat - rice system) can be realized by applying FYM 5 t/ha along with 50% of recommended dose of chemical fertilizers. However, FYM 2.5 t/ha + paddy/soybean straws may also be used to obtain comparatively lower productivity levels (31.4-31.6 q/ha).

Table 4. Residual effect of fertility levels applied to wheat on growth yield attributes and straw yield of succeeding rice crop

Treatment	Plant height (cm)			Tillers/m²			Grains/panicle			1000 grains weight (g)			Straw yield (q/ha)		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
50%	62.7	62.9	63.7	203	198	196	97.3	97.6	100.1	23.4	22.2	23.0	35.3	35.4	35.9
100%	65.0	65.1	65.4	229	224	221	105.9	104.7	107.8	24.4	22.9	24.5	40.8	40.8	40.2
150%	66.8	6.9	66.1	246	241	229	113.5	112.2	109.0	24.5	24.2	24.7	42.5	42.1	43.5
CD at 5%	3.15	NS	2.4	20	19	17	5.6	5.9	4.3	0.28	0.51	0.40	1.33	0.9	1.4

I : 2001-02, II : 2002-03, IIII : 2003-04

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YIELD AND WEED FLORA OF WHEAT (*TRITICUM AESTIVUM*) AS INFLUENCED BY TILLAGE OPTIONS AND FERTILITY LEVELS UNDER RAINFED TEMPERATE CONDITION

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ABSTRACT

A field experiment was carried out during winter seasons of 2006-07 and 2007-08 at the research farm of Faculty of Agriculture and Regional Research Station, Wadura, Sopore (J&K) to evaluate the relative performance of various tillage options and fertility levels in wheat after rice harvest. Among various tillage practices reduced tillage recorded markedly higher dry matter production and yield attributes (spike/m^2, grains/spike, spike length and 1 000 grain weight). Reduced tillage resulted in the highest yield of 3.5 t/ha. The reduced tillage was the best option and recorded highest net return (Rs 28 325/ha), followed by rotary (Rs 24 695/ha) and zero tillage (Rs 21 975/ha) and least with conventional tillage (Rs 18 910/ha). Markedly higher uptake of N, P and K was also recorded with reduced tillage followed by rotary tillage. Lowest weed count and dry weight was recorded under conventional tillage and greatest under zero tillage. Application of 100% recommended dose of fertilizer (60 kg N, 40 kg $P_2O_5$and 20 kg K_2O) recorded significantly higher dry matter accumulation, spike/m^2 grains/spike, spike length, 1,000 grain weight and grain (3.4 t/ha) and straw yield over lower fertility levels but remained on par with 125% recommended dose of fertilizer. Similarly, net return/rupee investment increased significantly up to 100% recommended dose of fertilizer. Application of 125% of the recommended dose of fertilizer recorderd significantly higher weed count, weed dry bio mass and N, P and K uptake by crop than recommended 75% and 50% of the recommended dose of fertilizer.

Key words : Economics, fertility, rainfed , temperate, tillage, weed, wheat, yield.

Wheat (*Triticum aestivum* L. emend. Fiori & Paol.) is a prime cereal crop and traditionally believed to require fine tilth for good yield. The time available between harvesting of rice and sowing of wheat is limited. Any delay in sowing might result in reduced yield. Farmers prepare land performing multiple tillage operations with various implements, especially after the harvest of rice, spending a huge amount of energy and time that increased the cost of production. In order to compete in international market and also to stabilize the support price, cost of production needs to be reduced. Due to single tractor sowing, zero and rotary tillage reduce the cost of land preparation (Chauhan *et al.*, 2003). There are also reports that weed flora is greatly influenced by tillage options (Chauhan *et al.*, 2003). For sustainable production system there is a need to integrate the various practices like tillage and fertility levels. Therefore, the present investigation was carried out to determine the effect of tillage and fertility levels on wheat (sown after rice) yield, economics, weeds and nutrient uptake.

MATERIALS AND METHODS

A field experiment was conducted during winter seasons of 2006-07 and 2007-08 at the Research Farm of the Faculty of Agriculture & Regional Research Station (SKUAST-Kashmir). Wadura, Sopore, in Kashmir situated at an elevation of 34° 17' N, 74° 33' E at an altitude of 1,524 m above mean sea level. The experimental soil was well drained silty- clay loam in texture (Eutrochrept) non saline (Ec 0.29 dS/m) with pH 7.4 (1:2.5 soil to water) and contained 0.72% organic carbon, 292 kg/ha available N, 22.3 kg/ha 0.5 M $NaHCO_3$ extractable available P and 252 kg/ha available K. The mean temperature during the experimental period ranged from -

8.8°C (January) to 36.6°C (June) in 2006-07 and - 8.5°C (January) in 2007-08 to 35.2°C (June) in 2007-08. The crop was grown under rainfed condition, no irrigation was applied and rainfall and snowfall so received during crop season in 2006-07(625.2mm) and 2007-08 (611.3mm) was utilized for raising crops. After the harvest of transplanted rice 16 treatment combinations consisting of 4 tillage options, *viz.*, conventional tillage followed by drill sowing involving 6 tractor passes (two disc, followed by two tractor ploughing and one each planker and ferti-seed drill); reduced tillage involving four tractor passes (one each with harrow, cultivator, planker and ferti-seed drill); rotary tillage and zero tillage and four fertility levels (50, 75, 100 and 125% of recommended dose of fertilizer) laid out in randomised block design, replicated three times. 'HS 240' wheat was sown using 100 kg seed/ha at the spacing of 22.5 cm under different treatments on 20 and 23 October during 2006 and 2007, respectively, on residual soil moisture immediately after harvesting of 'Shalimar Rice 1' transplanted rice. The recommended dose of fertilizer for wheat crop was 60, 40, 20 kg/ha of N, P_2O_5, K_2O, respectively. Full dose of phosphorus and potassium along with half dose of nitrogen as per designated rates were applied as basal dose at the time of wheat sowing. Rest of the nitrogen was top dressed treatment wise at CR1 and heading stages. The source of fertilizers were urea, diammonium phosphate and muriate of potash. In zero tillage, wheat was sown directly after rice harvest without field preparation using a specially designed machine having knife-type tynes that opens narrow seits in which seed and fertilizer are drilled simultaneously. In rotary tillage. land was cultivated using the rotor in front and seed and fertilizer were drilled at the back simultaneously in a single tractor operation. The observations on weed population and weed dry weight at harvest were recorded using a quadrant of 1.0 m^2. The crop was harvested on 13 June 2007 and 18 June 2008.

RESULTS AND DISCUSSION

Tillage options

The data recorded on dry matter production of wheat at harvest stage (Table 1) revealed that reduced tillage significantly enhanced drymatter production over rest of the tillage options. However, rotary, conventional and zero tillage options being on par with each other in terms of drymatter production.

The yield of wheat and yield attributes differed markedly due to tillage options. Reduced tillage had markedly higher number of spike/m^2, number of grains/spike, spike length and 1000 grain weight resulting in higher grain yield as compared to rotary, conventional and zero tillage (Table 1). The magnitude of increase in grain yield with reduced tillage was to the tune of 12.9, 20.6 and 25.0% over the reduced, conventional and zero tillage, respectively. This might be due to lesser number of weeds and reduced dry weight and increased availability of NO_3 N in reduced tillage that resulted in better growth, development of yield attributes and finally yield. (Singh *et al.* 2008).

Wheat sown in reduced tillage accrued the highest net return (Rs 28 325/ha and cost benefit ratio (1:1.33) followed by rotary tillage (Rs 24 695/ha and 1:1.32) and zero tillage (Rs 21 975 and 1:3.1) (Table 1). This was due to higher production and lower cost of cultivation incurred over conventional method. The saving in cost of cultivation was mainly because of lower fuel requirement for field preparation. These observations corroborate the findings of Chauhan *et al.* (2003).

The markedly higher uptake of nutrients (N, P and K) by wheat was recorded in plots seeded by reduced tillage followed by rotary, conventional and zero tillage owing to higher grain and straw yield (Table 2). Parihar (2004) also reported higher uptake of nutrients in reduced tilled wheat crop.

The highest weed population and weed dry weight was observed in zero tillage, followed by rotary, reduced and conventional tillage (Table2). The lowest weed dry weight and population of all grassy, sedges and broad leaved weeds in conventional tillage can be attributed to more initial crop vigour finally observed under this system, which might have made wheat more competitive and reduced density of major weeds under conventional tillage (Bisen and Singh, 2008).

Table 1. Growth, yield attributes, yield and economics of wheat as affected by tillage options and fertility levels (mean data of two years)

Treatment	Dry matter accumulation at harvest (t/ha)	Spike/m²	Grains/spike	Spike length (cm)	1000 gain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Cost of cultivation (Rs/ha)	Net income (Rs/ha)	Cost:benefit ratio
Tillage options										
Conventional	6.8	224	30.2	7.8	40.3	2.9	3.8	14.650	18,910	1:2.3
Rduced	7.9	261	36.7	9.1	43.2	3.5	4.7	12.315	28,325	1:3.3
Rotary	7.1	233	32.1	8.2	40.7	3.1	4.1	11.225	24,695	1:3.2
Zero	6.6	216	29.8	7.6	40.1	2.8	3.7	10.465	21,975	1:3.1
CD at 5%	0.6	22.4	3.1	0.6	2.1	0.3	0.4			
Fertility levels (% RDF)										
60	5.8	202	24.9	7.2	39.8	2.5	3.2	10.822	18,018	1:2.7
75	6.7	227	31.2	7.9	40.0	2.9	3.8	11.790	21,770	1:2.8
100	7.8	251	35.4	8.7	42.2	3.4	4.6	12.210	27,310	1:3.2
125	8.1	254	37.3	8.9	42.3	3.5	4.7	13.833	26,807	1:2.9
CD at 5%	0.6	22.4	3.1	0.6	2.1	0.3	0.4			

Sale price of wheat grain (MSP) was Rs 1.000/q and wheat straw was Rs. 120/q

Fertility levels

Increase in fertilizers dose from 75 to 100% recommended dose increased dry matter production significantly. Further increase in dose up to 125% of recommended levels gave dry matter of wheat crop at par with that of 100% recommended dose. The magnitude of increase in dry matter with 100% fertilizer dose was to the tune of 16.4 and 34.5°% over 75 and 50% fertilizer dose (Table 1).

With the increment in fertilizer dose from 50-125% of recommended dose produced significant variation in grain and straw yield and yield attributes. Application of 100% fertilizer dose recorded 17.2 and 36.0% higher grain yield over 75 and 50% recommended dose, respectively, but produced grain yield at par with 125% fertility level. Similarly, straw yield, number of spike/m², grains/spike, spike length and 1000 grain weight increased significantly up to 100% fertility level and thereafter remained at par with 125% recommended dose of fertilizer (Table 1). This may be due to the fact that recommended dose of fertilizer may have supplied nutrients to crop in optimum proportion required for their better growth and development (Gupta *et al.*, 2007 and Dutta *et al.*, 2005).

Markedly higher uptake of N, P and K was observed with 125% recommended dose of fertilizer over lower levels of the fertility. The magnitude of increase in N uptake with 125% fertilizer dose was to the tune of 9.1, 23.5 and 38.8% over 100, 75 and 50% recommended dose of fertilizer (Table 2). The increase in N, P and K uptake by wheat at 125% of the recommended dose of fertilizer might be due to greater crop biomass production under higher levels of fertilizer (Pandey *et al.*, 2006).

Weed count and dry weight differ significantly among levels of fertilizer. Moreover, 125% of the recommended dose of fertilizer recorded significantly higher weed population and weed dry biomass than the lower fertility levels. The increase in weed count and dry significantly among levels of fertilizer. Moreover, 125% of the recommended dose of fertilizer recorded significantly higher weed population

Table 2. Nutrient uptake and weeds as affected by tillage options and fertility levels (mean data of two years)

Treatment	Nutrient uptake (kg/ha)			Weed population/m²		Weed dry weight (g)
	N	P	K	Grassy+sedges	Broad leaves	
Tillage options						
Conventional	75.3	14.4	85.4	2.8 (5.3)	4.1 (14.2)	5.6 (28.7)
Reduced	86.4	17.2	96.3	3.1 (7.2)	4.5 (17.4)	5.9 (31.4)
Rotary	78.2	15.1	88.2	3.4 (8.3)	4.8 (19.1)	6.0 (33.1)
Zero	72.6	14.2	83.6	3.5 (9.7)	4.9 (22.3)	6.3 (36.6)
CD at 5%	6.8	1.2	7.1	0.2	0.3	0.2
Fertility levels (% RDF)						
50	65.3	12.7	77.2	2.9 (5.4)	4.0 (13.8)	5.4 (27.8)
75	73.4	14.6	84.7	3.1 (6.5)	4.4 (16.4)	5.7 (29.7)
100	83.1	16.1	91.9	3.3 (8.4)	4.8 (19.6)	6.1 (34.7)
125	90.7	17.5	99.7	3.6 (10.2)	5.2 (23.2)	6.4 (37.6)
CD at 5%	6.8	1.2	7.1	0.2	0.3	0.2

Figures in parentheses indicate original values

and weed dry biomass than the lower fertility levels. The increase in weed count and dry weight at higher fertility level resulted from higher availability of nutrients which helped in build up of better vegetative growth (Pandey et al., 2006).

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EFFECT OF *TRICHODERMA* SPP. USED AS SEED TREATMENT ON GERMINATION AND MORTALITY OF CHICKPEA

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Chickpea crop suffers due to different stresses. Of these, biotic constraints are important particularly soil borne diseases and insect pests. These organisms are responsible to a greater extent for instability in yield of the crop in major production areas of the world. Chickpea is cultivated throughout the state of Chhattisgarh. It is widely grown in plains of Chhattisgarh, Northern hill regions and Bastar plateau. It is grown under both rainfed and irrigated conditions. The major yield losses caused by diseases are occurring from pre-emergence to the maturity of crop. Most of these are caused by fungi associated with seed and soil. More than 50 pathogens have bee reported to infect chickpea in different parts of world (Nene *et al.*, 1989).

S. rolfsii causing collar rot is an important soil borne and fast spreading fungal pathogen, which causes considerable damage to the plant stand. Seedling mortality in chickpea due to *S. rolfsii* has been reported to vary from 54.7 to 95.00 per cent. Under field conditions, the *S. rolfsii* has been reported to cause 22 to 50 per cent reduction in yield of chickpea (Shrivastava *et al.*, 1984).

The experiment was conducted during 2003-04 to find out an effective antagonist enhancing germination and minimizing mortality of seedlings. Plastic pots of 10 cm diameter were filled with inoculated soil. The soil was inoculated with test fungus *Sclerotium rolfsii* grown on soil maize medium. Seed of susceptible cultivar of chickpea BG-1003 were treated with different species and isolates of *Trichoderma* spp. Six seeds were sown in each plot. Untreated seeds sown in the inoculated soil served as check. Three replications were maintained. Observation on germination, pre and post emergence mortality were recorded.

The results of seed treatment with Trichoderma spp. and their effect on germination, pre and post emergence mortality caused by *Sclerotium rolfsii* were recorded and presented in Table 1.

There was significant difference in germination of the seeds treated with some isolates of *Trichoderma* and control. Maximum germination of chickpea (77.77%) was observed when the chickpea seeds were treated with *T. viride* (Kanpur) followed by *T. harzianum* (Kanpur) (61.10), *T. harzianum* (Parbhani) (55.55), *T. viride* (Parbhani) (49.99). However, the germination was least (38.88%) when the seeds were treated with *Trichoderma* spp. (PSR) which was equal to seed germination (38.88%) in control.

The pre-emergence mortality in chickpea also differed significantly in two treatment. It was significantly least (22.21%) in seeds treated with *T. viride* (Kanpur) followed by germination (38.88%) in *T. harzianum* (Kanpur). But the pre-emergence mortality was highest (61.10%) when the seeds were treated with Trichoderma spp. (PSR), which was equal to mortality in control. All the treatment showed significantly least post emergence mortality as compared to control. Similarly, the post-emergence mortality was significantly least (21.66%) in seed treated with *T. viride* (Kanpur), followed by *T. harzianum* (Kanpur) (36.11%), *T. viride* (Parbhani) (36.11%), *T. harzianum* (Parbhani), (38.88%) as compared to 100% mortality in control. The mean mortality was also least (21.93%) in seeds treated with *T. Viride* (Kanpur) followed by *T. harzianum* (Kanpur) (37.49%), *T. harzianum* (Parbhani)(41.66) and *T. viride* (Parbhani) (43.05).

Seed treatment with all the six *Trichoderma*

Table 1. Effect of seed treatment by different species and local isolates of *Trichoderma* on germination, pre and post emergence mortality of chickpea caused by *Sclerotium rolfsii*

Isolates of Trichoderma	Germination %	Mortality (%)		
		Pre-emergence	Post-emergence	Average mortality (%)
Trichoderma harzianum(K)	61.10 **(51.46)**	38.88 **(38.49)**	36.11 **(36.73)**	37.49
Trichoderma viride (K)	77.77 **(62.15)**	22.21 **(27.80)**	21.66 **(38.88)**	21.93
Trichoderma harzianum (P)	55.55 **(48.22)**	44.44 **(41.73)**	38.88 **(38.49)**	41.66
Trichoderma viride (P)	49.99 **(44.98)**	49.99 **(44.98)**	36.11 **(36.73)**	43.05
Trichoderma spp. (MBR)	44.44 **(41.73)**	55.55 **(48.22)**	49.99 **(44.98)**	52.77
Trichoderma spp. (PSR)	38.88 **(38.49)**	61.10 **(51.46)**	44.44 **(41.73)**	52.77
Control	38.88 **(38.49)**	61.10 **(51.46)**	100.00 **(89.31)**	80.55
SEm ±	3.74	3.74	3.75	-
CD at 5 %	11.35	11.35	11.40	-

Data in parenthesis shows Arc sine transformation

(K) = Kanpur isolate (PSR) = Isolated from paddy straw, Raipur

(P) = Parbhani isolate (MBR) = Isolated from mushroom, Raipur

spp. including local isolates were found to be effective against *Sclerotium rofsii* in increasing gerination and decreasing the mortality of seedlings over control. *Trichoderma viride, T. harzianum* (Kanpur isolate) and *T. harzianum, T. viride* (Parbhani isolate) gave good percentage (77.77, 61.10, 55.55 and 49.99%, respectively) and minimum average mortality (21.93%). Similar results were also reported by Sugha *et al.* (1993) and Biswas and Sen (2000).

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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON GROWTH AND YIELD OF SWEET CORN (*ZEA MAYS* L. SSP.*SACCHARATA*)

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Maize is a versatile product with uses ranging from industrial products to food preparations, as well as direct human consumption at the vegetative stage. The immature ears are used after roasting. boiling or canning. For this, cultivars with enhanced sugar content are most suitable and are preferred (Meena *et al.*, 2005).

Rajasthan is one of the important maize growing states in the country) to which Udaipur region contributes 70 per cent of the area and production. Being a high value crop, there is a growing demand of sweet corn in star hotels. The farmers dwelling at the outskirts of the cities can take up this crop for better profits. Added advantage of sweet corn is that after the harvest of green ears, the crop remains green and it is fit for feeding cattle as green fodder. Due to its short duration. it finding place in different cropping systems. Higher yield of sweet corn can he obtained through the use of nutrients. Judicious use of plant nutrients is a key to bumper maize crop production as they alone contribute 40-60 per cent of the crop yield (Dayanand, 1998). In Udaipur region, the most acceptable recommendation for nitrogen and phosphorus fertilization for maize is 60-90 kg N and 30 kg P_2O_5 ha^{-1} (MPUAT, 2004). However, there is no separate recommendation for the specially corn *viz.* sweet corn, therefore, necessitating experimentation to find out appropriate dose of N+P for this newly introduced crop in the zone. The mineral fertilizer has and will continue to play the key role in the augmentation of the food production in the entire world. In India. the high yielding varieties of cereals ushered in the 'Green Revolution' have worked as a catalyst in increasing the fertilizer demand (Prasad, 2000). Due to escalating cost of chemical fertilizers and objective of minimizing environmental pollution, the search of alternative source of plant nutrients is imperative. The integrated plant nutrient supply envisages conjunctive use of inorganic and organic sources of plant nutrients for crop productivity besides sustaining soil health (Singh, 2006).

A field experiment was conducted at Udaipur during rainy season of 200. The soil was clay loam having alkaline reaction (pH 7.8). It was medium in total nitrogen (260.40 kg/ha), available phosphorus (18.26 kg/ha) and high in available potassium (283.30 kg/ha). The experiment comprised of 20 treatment combinations consisting of 4 fertility levels (50 + 25, 70 + 35. 90 + 45 and 110 + 55 kg N + P_2O_5/ha) and 5 nutrient sources (fertilizers. Vernicompost, 50% fertilizers + 50% vermicompost, 40% fertilizers + 40% vermicompost + seed treatment with *Azotobacter* + PSB and 50% fertilizer + 50% vermicompost + seed treatment with *Azotobacter* + PSB).

The treatments were laid out in factorial randomized block design and replicated thrice. The crop cv Madhuri was sown on 7th July using seed rate 20 kg ha-1 at a geometry 60 cm x 25 cm. The green cobs were harvested between 7-14 September and green fodder on 15 September. As per treatment. vermicompost was broadcast and incorporated in plots a day prior to sowing. The entire quantity of phosphorus and half quantity of nitrogen through fertilizers as drilled in crop rows through DAP and urea while sowing and remaining half nitrogen was top dressed one month after sowing.

Increase in fertility levels tended to increase the plant height at 45 and 60 DAS, however, significance was observed only upto 70 kg N + 35 kg P_2O_5/ha which recorded 4.5 and 5.4 % increase in height over 50 kg N + 25 kg P_2O_5/ha. The minimum LAI at 45 and 60 DAS (2.4 and 3.2, respectively) were observed with 50 kg N + 25 kg P_2O_5/ha. These LAI increased by 16.7 and 12.5%, respectively by applying 70 kg N + 35 kg P_2O_5/ha. The dry matter accumulation increased significantly by enhancing the fertility level upto 90 kg N + 45 kg P_2O_5/ha. An increase of 11 .6% and 16.9 % in cob length and cob girth were recorded when the fertility level as raised from 50 + 25 to 70 + 35 kg N + P_2O_5/ha. An application of 110 kg N + 55 kg P_2O_5/ha accounted for significant increase (10.1%) over 70 kg N + 35kg P_2O_5/ha in cob girth.

Amongst various sources used to supply nutrients, 100% application through chemical fertilizers resulted in maximum plant height (145.1 and 180.2 cm) at 45 and 60 DAS, respectively. However, the effect of this treatment was at par to chemical fertilizers + vermicompost (50:50) along with seed inoculation with Azotobcter + PSB. Significantly higher LAI (3.06 and 3.85) at 45 and 60 DAS, respectively were recorded when the crop was supplied the nutrients through chemical fertilizers only. Although the maximum cob length and girth (20.59 and 15.32 cm) were recorded when the crop was provided with the entire quantity of nutrients through chemical fertilizers. However, it was at par with the treatment comprising of fertilizers (50%) + vermicompost (50%) and dual bacterial inoculation.

There was no significant variation in number of cobs/plant with change in fertility level, however, an application of 70 kg N + 35 kg P_2O_5/ha registered a significant increase (11 .0%) in individual cob weight of sweet corn in comparison to 50 kg N + 25 kg P_2O_5/ha.

The grain rows/cob were not affected. Significant increase of 11 .0 and 9.8% in cob and biological yield. respectively were observed by raising the fertility level from 50 kgN+25 kg P_2O_5/ha to 70 kg N + 35 kg P_2O_5/ba. Further increase in rate of nutrient application had no significant effect on cob and biological yield. However, the green fodder yield after the harvest of green cobs was significantly higher up to 90 kg N + 45 kg P_2O_5/ha.

The maximum number of cobs/plant (1 .2) was seen by giving the entire quantity of nutrients through fertilizers which was at par with 50% fertilizer + 50% vermicompost with and without seed inoculation. The maximum single cob weight, green crop, green fodder and biological yields were recorded when the entire quantity of nutrient was applied through chemical fertilizers which was significantly greater in comparison to the different other sources in question except fertilizers + vermicompost (50:50) + seed inoculation. Also the minimum yields were obtained by 100% vermicompost application.

The maximum net returns (Rs 37 thousand/ ha) were achieved by applying (110 kg N +55 kg P_2O_5/ha), but this was at par to 90 kg N +45 kg P_2O_5/ha and 70 kg N +35 kg P_2O_5/ha. The minimum NR were obtained by applying lowest of nutrient (50 + 25 kg N and P_2O_5/ha). However, the fertility levels did not show perceptible change in B:C. The maximum net returns and B:C were observed with 100% chemical fertilizers.

The results of present investigation corroborate with the findings of few previous studies (Pathak *et al.*, 2002: Mundra *et al.* 2002: Khadtare *et al.* 2006 a and b and Chillar and Kumar, 2006).

Table 1. Effect of fertility levels and nutrient sources on growth

Treatments	Plant height		LAI		Dry matter accumulation		Cob length (cm)	Cob girth (cm)
	45 DAS	60 DAS	45 DAS	60 DAS	45 DAS	60 DAS		
Fertility levels (N + P_2O_5 kg/ha)								
50 + 25	130.7	163.9	2.40	3.20	40.6	61.0	17.2	11.8
70 + 35	136.7	172.7	2.80	3.60	48.5	73.8	19.2	13.8
90 + 45	144.1	177.2	2.90	3.70	52.5	81.0	19.4	14.9
110 + 55	144.9	178.6	2.90	3.80	52.5	83.8	19.8	15.2
C.D. 5%	6.70	8.73	0.23	0.30	3.78	5.93	1.87	1.19
Nutrient sources								
100% FRT	145.1	180.2	3.06	3.85	52.0	80.2	20.59	15.32
100% VC	135.1	165.7	2.58	3.40	45.6	69.2	18.24	13.38
50% FRT + 50 % VC	138.4	172.8	2.71	3.53	48.0	74.0	17.81	13.30
40% FRT + 40% VC + inoculation	136.3	171.8	2.58	3.40	48.0	73.0	18.29	13.38
50% FRT + 50% VC + inoculation	140.1	174.7	2.70	3.53	49.0	78.0	19.51	14.31
C.D. 5%	5.99	7.81	0.21	0.27	3.38	5.30	1.67	1.06

Table 2.Effect of fertility levels and nutrient sources on yield attributes, yield and economics

Treatments	Cobs/ plant	Grain rows/cob	Cob weight (g/cob)	Yield (q/ha)			Net returns (Rs '000)	B:C
				Green cob	Green fodder	Biological yield		
Fertility levels (N + P_2O_5 kg/ha)								
50 + 25	1.1	14.4	108.0	70.1	169.8	239.9	32.9	3.10
70 + 35	1.1	14.6	119.9	75.3	187.6	262.8	35.4	3.10
90 + 45	1.2	14.4	121.6	76.6	200.0	276.6	35.8	2.90
110 + 55	1.2	14.6	122.7	80.1	207.2	287.3	37.0	2.90
C.D. 5%	N.S.	N.S.	9.91	4.96	11.30	16.15	3.03	N.S.
Nutrient sources								
100% FRT	1.35	14.5	128.6	80.3	202.5	282.8	40.3	4.05
100% VC	1.07	14.5	112.2	71.1	180.0	251.2	30.2	2.11
50% FRT + 50 % VC	1.17	14.5	115.1	75.4	190.9	266.4	35.1	2.89
40% FRT + 40% VC + inoculation	1.07	14.5	112.8	74.4	188.7	263.1	35.2	3.06
50% FRT + 50% VC + inoculation	1.20	14.5	121.7	76.3	193.5	269.8	35.5	2.91
C.D. 5%	0.09	N.S	8.86	4.43	10.11	14.44	2.71	0.23

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EFFECT OF QUALITY OF CALCIUM CARBONATE ON GROWTH AND VIGOUR OF THE SPAWN OF PADDY STRAW MUSHROOM

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A private commercial spawn laboratory at Guwahati was facing the problem of slow growth of spawn of Pleurotus sp. It was found that this spawn laboratory was using a cheaper grade (Rs. 6 per kg) of calcium carbonate ($CaCO_3$) which is known as French chalk and sold in the hardware shops. It was relatively rough in texture as compared to other grades of $CaCO_3$. The purpose of coating the grain with $CaCO_3$ @2% was not only to reduce stickiness of the parboiled grains but also to raise the pH to 7.5 or above, which is optimum for spawn growth. The above problem prompted us to study the effect of different grades of $CaCO_3$ on the rate of growth of spawn. Different grades of $CaCO_3$ were available in the market with their price ranging from Rs. 6/- to 130/- per kg.. A cheaper grade of $CaCO_3$ was preferred by the commercial spawn laboratories in order to cut down the cost of spawn production. The goal of this work was to find out the best as well as the economical grade of $CaCO_3$ for spawn production.

Four grades of $CaCO_3$ (Table 1) were tested twice during May to August, 2005. The pharmaceutical grade was from M/s B.D. Pharmaceutical Works, Bengal. Paddy grain was used as the base for the spawn of *Volvariella volvacea*. Paddy was processed in a mm parboiling drum[3]. The cooked paddy grains were mixed with different grades of $CaCO_3$ @2% of the weight of grain. However, the lab reagent grade $CaCO_3$ which is 90% pure was tested at two doses, *viz.* 1% and 2%.

Three hundred prams of grains were filled in empty saline bottles and autoclaved at 121°C for 1.5 hrs. Eight replications were maintained for each treatment. The pH of the grain was tested after autoclaving. Twenty live grams of paddy grain were mixed in 70 ml of distilled water and pH was recorded. The spawn bottles were seeded with culture of *V. volvacea* and incubated at 30°C. The rate of growth was observed every day. The number of days required for completing the growth in the spawn bottle was noted. Further the per cent area of the inner surface of the spawn bottle covered by the brick red patches were recorded on 15th day after incubation. The yield capacity of the spawn from six treatments was also tested. Rectangular beds were made with 16 bundles of straw There were three replications for each treatment.

The results are presented in Table 1. The pH of the spawn grain was the best in pharmaceutical grade followed by the lab reagent grade $CaCO_3$. The pH was relatively lowest in French chalk. The pHof the grain substrate is a crucial deciding factor for the growth of the spawn. The optimum pH for the growth of mycelium of *V. volvacea* is 7.5[1]. The slow growth of spawn was the consequence of below optimum level of pH of the substrate. The development of brick red patches consisting of chlamydospores of *V. volvacea* on the inner of the bottle indicated the vigour of the spawn. Munjal[2] stated that the number of chlamydospores formed by *V. volvacea* in the spawn was correlated with higher yield. The vigour of the spawn was best in pharmaceutical grade. It was at par with that of lab reagent grade $CaCO_3$ at 2% as well as at 1%. The overall effectiveness of pharmaceutical $CaCO_3$ is equal to that of lab reagent $CaCO_3$. The major advantage of pharmaceutical $CaCO_3$ is that it is three times cheaper than lab reagent $CaCO_3$. This will cut down the cost of production of spawn. Chalk powder used for polishing of wood was next to pharmaceutical CaCO3 in terms of effectiveness. The 2% rate of application of lab

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Table 1. Effect of quality of calcium carbonate on the pH, growth and vigour of spawn of Volvariella volvacea

Treatment	Rate of application (%)	pH of grain after autoclaving	No. of days required for completing growth	% Surfac covered by chlamydospores	Price (Rs.)
Lab reagent, CDH, 98% pure	2	9.03	10.00	88.75	130
Lab reagent, CDH, 98% pure	1	8.88	10.50	85.00	130
Pharmaceutical grade	2	9.25	10.00	92.50	45
Chalk powder used for polishing wood	2	7.95	11.00	71.25	6
Frenck chalk	2	6.04	14.50	25.00	6
Check, no $CaCO_3$	Nil	6.88	14.50	22.50	Nil
CD at 5%			0.65	13.63	

reagent grade $CaCO_3$ is at par with 1% rate. Therefore, the quantity of lab reagent $CaCO_3$ can be brought down to 1%. French chalk was equal to no- $CaCO_3$ treatment.

The yield data of mushroom was not worth presenting because there was no difference in treatments. The figures did not reflect the vigour of spawn. The following conclusion was drawn based on the above results:

i. French chalk should not be used for spawn production.

ii. Pharmaceutical grade is recommended for spawn production because its cost is 3 times lesser than that of lab reagent grade $CaCO_3$.

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RESPONSE OF VEGETABLE LAHI (*BRASSICA JUNCEA* VAR. RUGOSA) TO FREQUENCY OF LEAF PICKING AND PLANT SPACING IN HILLS

TRIBHUWAN PANT, M. C. PANDEY, VANDNA PANDEY AND Z. AHMED

Defence Agricultural Research Laboratory, Pithoragarh

ABSTRACT

A field experiment was conducted at the experiment station of Defence Agricultural Research Laboratory Pithoragarh (1700 M) during the year 2003-04 and 2004-05 in Rabi season in a split plot design taking leaf picking as main plot and spacing as sub plot treatment. It was observed that maximum green leaf yield may be obtained when crop was transplanted at 30x 30 cm. spacing followed by 30 x 45 and 45 x 45 cm respectively. The leaf yield also increased with increase in number of pickings up to three. The picking did not affected the grain yield, however spacing had its significant edge in affecting the grain yield and maximum grain yield was recorded at 30 x 30 cm spacing

Key words : Lahi, leaf picking, plant spacing, grain yield.

Lahi (*Brassica juncea*.var. rugosa) is well known in hills as green vegetable during the winter season. It is a rich source of vitamins and minerals and contains vita. A, vita. C, calcium, iron, phosphorus (Rawat ., 1978). The crop is grown by direct sowing or by transplanting. The transplanting method is superior for getting higher leaf yield. The yield can also be increased by adjusting the time of planting and by proper fertilizer schedule and irrigation. Spacing for transplanting and frequency of leaf picking at different intervals is also an important aspect for getting higher green leaf and grain yield. The different spacing for different varieties of cabbage, has also been reported by Diana *et al.*, (1970) and Flones (1970). Therefore the study was undertaken to find out the best suitable spacing combination for transplanting and frequency of leaf picking for getting green leaf and grain yield of lahi, which is an important vegetable crop of hills.

MATERIALS AND METHODS

A field experiment was conducted at the experiment station of Defence Agricultural Research Laboratory in Pithoragarh hills (1700 M) during the Rabi seasons of 2003-04 and 2004-05 in a split plot design taking leaf picking (no picking, one picking, two pickings and three pickings) as main plot treatments and spacing combinations (30 x 30, 30 x 45, 30 x 60, 45 x 45,45x 60, and 60x60 cm) as sub plot treatments. There were three replications. The crop was fertilized uniformly with 100 kg N, 60 kg P_2O_5 and 30 kg K_2O/ha in addition to FYM. The transplanting was done on 15th November 2003 and 17th October in 2004, respectively. The crop was irrigated uniformly as and when required.

RESULT AND DISCUSSIONS

The green leaf yield of Lahi increased by increasing the number of picking and maximum leaf yield (192.93 q /ha in 2003 - 04 and 255.72 q/ha in 2004 - 05) was recorded when leaf picking was done three times (Table 1). Spacing also had significant effect in increasing the leaf yield of Lahi and maximum yield was recorded in 30 x 30 cm spacing in both the years, when individual plant occupied 0.09 sq.m. area followed by 30 x 45 and 45 x 45 cm when plant occupied 0.135 and 0.27 sq.m. area respectively thus with increase in space occupied by plant the leaf yield decreased. Hence the narrow spacing had shown the tendency of giving higher leaf yield. Higher yield with narrow spacing was also reported in bróccoli and okra by Kumar *et al.*, (2007) and Hossain *et al.*, (2007), respectively.

Table 1. Effect of leaf picking and spacing on the green leaf yield (q/ha) of lahi

Treatment	2003-04	2004-05	Average
Picking			
One picking	57.48	114.95	86.21
Two picking	110.98	199.79	155.38
Three picking	192.73	255.72	224.22
SEM±	5.15	7.76	
CD at 5%	14.3	21.54	
Spacing (cm)			
30 x 30	164.97	256.21	210.55
30 x 45	156.41	239.40	197.90
30 x 60	73.68	174.20	123.94
45 x 45	146.27	205.54	175.90
45 x 60	97.93	131.99	114.96
60 x 60	83.08	133.59	108.32
SEM±	5.46	5.15	
CD at 5%	15.77	14.88	

Table 2. Interaction effect of picking and spacing on the leaf yield (q/ha) of lahi

Spacing (cm)	Area/plant sq.m.	2003-04			2004-05		
		P_1	P_2	P_3	P_1	P_2	P_3
30 x 30	0.9	87.96	119.93	287.03	157.98	260.99	349.67
30 x 45	0.135	91.47	116.97	260.80	143.38	239.50	335.32
30 x 60	0.18	35.29	55.84	129.91	128.24	179.39	214.98
45 x 45	0.27	55.63	151.93	231.76	110.28	205.45	300.90
45 x 60	0.203	52.15	117.27	124.38	73.45	157.40	165.12
60 x 60	0.36	22.27	104.45	122.54	76.38	155.96	168.38
For comparing two sub plot treatment at			SEM±	CD at 5%		SEM±	CD at 5%
one level of main plot,			9.46	28.78		8.93	28.60
For comparing any two treatment combinations of spacing x picking			22.96	69.91		24.97	77.25

The interaction effect of picking and spacing also affected the green leaf yield conspicuously (Table 2). The maximum leaf yield 287.03 and 349.67 q/ha in 2003 - 04 and 2004 - 05 respectively was recorded in 30 x 30 cm row and plant spacing combination with three pickings when plants were equal-distanced and it could be attributed that plants intercepted the maximum solar radiation and utilized the water and nutrients from soil most efficiently. The second best treatment was 30 x 45 cm spacing with three picking which gave 260.80 q/ha and 335.32 q/ha leaf yield in 2003 - 04 and 2004-05 respectively because of the chance of the getting more leaves.

The crop after picking the leaves as per treatment was left for recording its potential of grain yield .It was observed that leaf picking did not influenced the grain yield significantly (Table 3). Thus it can be presumed that the leave appearing in main stalk during growth of stalk and branching after the crop enters into reproductive phase may be contributing more in grain production. However, spacing was found to have its significant effect in affecting the grain yield. The best spacing combination was 30 x 30 and 30 x 45 cm., however, 45 x 45 cm was also quite promising in comparison to 60 x 60 cm. Flones (1970) also reported 40 cm spacing

Table 3. Effect of leaf picking and spacing on the grain yield of Lahi (q/ha)

Treatment	2003-04	2004-05	Average
Picking			
No picking	12.39	4.40	8.39
One picking	13.03	3.35	8.19
Two picking	12.67	4.13	8.40
Three picking	14.15	3.94	9.04
CD at 5%	NS	NS	
Spacing (cm)			
30 x 30	15.14	5.41	10.27
30 x 45	16.66	4.14	10.42
30 x 60	10.77	3.53	7.15
45 x 45	15.06	3.61	9.33
45 x 60	11.37	3.87	7.62
60 x 60	9.85	3.10	6.47
SEM±	1.15	0.30	
CD at 5%	3.30	0.86	

for Blatop an Amager variety of cabbage, however, the best marketable size was reported at 30 cm spacing. It was also noticed that middle October planting gives more leaf yield and middle November planting is good for getting higher seed yield in hills.

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PRODUCTIVITY AND SUSTAINABILITY OF DIFFERENT CROP ESTABLISHMENT METHODS FOR CULTIVATION OF *RABI* RICE IN WESTERN ORISSA

J. Halder, K.C. Sahoo, S.K. Karmaker and R.N. Nayak

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Abstract

A field experiment was carried out during *rabi* season of 2004-05 and 2005-06 to study sustainability of different crop establishment methods on growth and yield of transplanted *rabi* rice. Among the six crop establishment methods raising rice crop by system of rice intensification method (SRI) resulted in significantly higher grain yield (6.09 t/ha) with better expression of yield attributes. Growing rice crop by system of rice intensification method recorded significantly higher number of panicles, panicle weight and filled spikelets panicle/m.

Key words : Crop establishment method, rice, SRI.

In western Orissa, *rabi* rice is grown by conventional method of transplanting requiring more water and labor, which is expensive. Each kg of rice requires 3000 to 5000 liters. Scarcity of labour at peak period delays rice transplanting by conventional method resulting in low productivity of *rabi* rice (Pyare *et al.*, 1982). Hence it needs to be investigated on improving water productivity and also to reduce the cost of labour for planting to produce more rice with less water.

Keeping this in mind the present investigation was carried out to find out the suitable crop establishment method rice, to reduce cost of labour and also to increase water use efficiency for cultivation of rabi rice in western Orissa.

Materials and Methods

The experiment was conducted during the *rabi* season of 2004-05and 2005-06 at Regional Research and Technology Transfer Station, Chiplima, Sambalpur. The soil of experimental field was sandy clay loam in texture having pH 6.4, organic carbon 0.48% and available nitrogen, phosphorus, potassium 251,1 6.5 and 250 kg/ha respectively.

The experiment comprising of 6 treatments, *viz.* standard practice of transplanting (T_1) system of rice intensification (SRI) (T_2), integrated crop management (1CM) (T_3), direct seeding with 8 row drum seeder at same day after puddling (T_4) and manual broadcasting direct seeding with 8 m drum seeder at one day of the pudding (T_5) were evaluated in randomized block design with 4 replications. The variety 'lalat' was tested with recommended doses of N P K and Zn @ 120:60:60 and 25 kg/ha. Half of N and full dose of P, K and Zn were applied as basal and remaining half of N as applied in two equal splits at active tillering, and panicle initiation stage. Manual weeding was done at initiation of tillering and at active tiliering. In system of rice intensification method, 10 day old seedlings were planted in the main field maintaining row to row spacing 20 cm and plant to plant 15 cm apart. For direct sowing, pregerminated seed was sown in the main field by 8 row drum seeder. The leaf area was adjusted by multiplying with adjustment factor (k) at the respective growth stages. The data on weed count and dry weight of weed in rice was analyzed using square root (x+0.5) transformation. The leaf blade and shoot portions were dried separately in an oven at 70°C for at least 72 hours. The dry weights of leaf blades and shoot portions were used to compare dry matter accumulation. Various crop growth parameters such as crop growth rate (CGR), relative growth rate (RGR), net assimilation rate (NAR), leaf area index (LAI) and leaf area duration (LAD) were calculated using leaf area, dry weight and total dry matter. Observations on plant height, panicle number, panicle weight 1000 grain weight, biological yield, harvest index, grain and straw yield were also recorded.

RESULTS AND DISCUSSION

Leaf area index

Planting methods had significant effect on LAI at all the stages of crop growth. It increased up to flowering, there after declined at harvest due to leaf senescence. The leaf area index which gives an idea of photosynthesizing surface increased progressively up to flowering and decreased there after (Table 2). Planting rice by system of rice intensification method exhibited fast leaf area development which suppress the weed population, weed growth and better competitiveness against weeds at early growth stage. Cultivation of rice by system of rice intensification method resulted in higher leaf area index might have positive effect on grain filling as recorded higher number of filled spike lets/panicle as compared to other methods of crop establishment. System of rice intensification method recorded significantly higher LAI at all the growth stages over transplanting, direct seeding with 8 row drum seeder and broadcasting methods. This might be due to increased number of green leaves and more number of shoots per unit area resulted from better utilization of moisture and nutrients.

Leaf area duration

Planting methods influenced leaf area duration of the crop. Leaf area duration which measures the ability of the plant to produce and maintain leaf area which increased with advancement of the crop age being maximum between 60 days after establishment (DAE) and flowering. Rice crop planted by system of rice intensification method recorded the highest LAD followed by standard practice of transplanting.

Dry matter accumulation

Dry matter production showed an increase with the progressive stage of development and reached maximum at harvest stage. Rice crop raised by system of rice intensification method resulted in higher dry matter production at harvesting stage as compared to other methods of planting. The lowest dry matter accumulation were recorded under manual broadcasting method of rice sowing possibly due to greater inter and intra plant competition for different available growth resources which decreased the height, number of leaves and LAI.

Net assimilation rate

Net assimilation rate was maximum during 60 DAE (PI stage)---90 DRE (flowering stage). Higher net assimilation rate was recorded by rice crop cultivated by system of rice intensification method followed by standard method of transplanting.

Crop growth rate

The crop growth rate increased gradually up to flowering and attained its maximum between 60 DAE and flowering (90 DAE). Among the six crop establishment methods rice

Table 1. Plant height and days to 50% flowering as influenced by crop establishment Methods

Treatment	Plant height			Total tillers/m_2			50% flowering (days)			Duration (days)		
	2004-05	2005-06	pooled	2004-05	2005-06	pooled	2004-05	2005-06	pooled	2004-05	2005-06	pooled
T_1	104.6	106.3	105.4	541	553	547	110	113	111.5	139	142	140.5
T_2	108.5	110.4	109.4	659	685	672	99	102	100.5	130	132	102.2
T_3	102.2	104.8	103.5	533	542	537.5	104	106	105.5	133	135	134.0
T_4	100.1	102.5	101.3	502	517	509.5	108	110	109.0	137	140.0	138.5
T_5	102.6	105.1	103.5	513	530	521.5	107	109	108.0	134	136	135.0
T_6	99.4	103.6	101.5	494	507	500.5	105	107	106.6	133	134	133.5
.D (P=0.05)	4.1	5.0	4.8	46.9	50.2	41.8	6.8	5.4	6.2	8.2	7.8	9.2

Table 2. Dry matter (to/ha) and leaf area index as influenced by different crop establishment methods

Treatment	Dry matter production(t/ha)						Leaf area index					
	2004-05			2005-06			2004-05			2005-06		
	PIS	50% flowering	Harvest	PIS	50% flowering	Harvest	PIS	50% flowering	Harvest	PIS	50% flowering	Harvest
T_1	2.1	4.4	8.6	2.4	4.7	8.8	2.37	6.40	1.83	2.40	6.45	1.86
T_2	2.7	5.6	10.1	2.9	5.8	10.7	2.72	6.90	2.01	2.91	6.96	2.10
T_3	2.0	4.2	4.4	2.3	4.5	8.4	2.3	6.35	1.80	2.35	6.41	1.82
T_4	2.0	3.9	4.2	2.1	4.2	8.0	2.28	6.32	1.76	2.31	6.38	1.80
T_5	2.1	4.0	4.3	2.2	4.4	8.2	2.33	6.33	1.78	2.32	6.40	1.80
T_6	1.9	3.8	4.0	2.0	4.1	7.2	2.26	6.29	1.74	2.27	6.35	1.77
C.D (p=0.5)	0.061	0.12	0.08	0.04	0.09	0.14	0.05	0.12	0.07	0.05	0.18	0.02

Table 3. CGR (gm/day) RGR (mg/g/day) as influenced by different crop establishment

Treatment	Crop growth rate (gm/day)						Relative growth rate (mg/g/day)					
	2004-2005			2005-2006			2004-2005			2005-2006		
	30-60 DAE	60-90 DAE	90-120 DAE	30-60 DAE	60-90 DAE	90-120 DAE	30-60 DAE	60-90 DAE	90-120 DAE	30-60 DAE	60-90 DAE	90-120 DAE
T_1	10.6	22.3	6.5	10.8	24.6	6.8	64.9	76.5	20.3	68.6	79.3	23.3
T_2	12.8	28.9	8.4	13.1	30.2	8.6	71.3	83.2	25.6	75.7	85.8	27.8
T_3	10.3	20.4	6.1	10.6	23.3	6.3	31.3	72.1	19.2	63.4	78.5	21.6
T_4	9.7	18.0	5.4	10.3	20.4	5.7	52.6	62.8	18.1	56.3	67.1	19.4
T_5	10.1	18.5	5.8	10.1	21	6.0	57.4	67.8	18.5	59.8	70.3	20.1
T_6	9.2	17.8	5.1	9.6	19.6	5.5	50.8	61.2	17.6	52.4	64.6	18.4
CD (p=0.5)	1.2	10.5	1.06	1.5	13.2	1.0	11.8	12.3	10.8	13.6	12.9	11.2

crop raised by system of rice intensification method showed significantly higher crop growth rate over other methods of rice planting. Early vegetative growth due to quick establishment of rice plant raised by system of rice intensification showed better interception of solar radiation and determines net photosynthesis which resulted higher grain yield.

Yield components

Among the six planting methods system of rice intensification method recorded maximum panicle/m, more panicle weight and panicle length which was found significantly superior to the other treatments. It was also found that cultivation of rice crop by system of rice intensification recorded significantly more number of spike lets/panicle and filled spikelets/panicle as compared to other methods of rice planting.

Grain and straw Yield

Data on grain yield (Table 7) indicated that planting of rice by system of rice intensification method recorded significantly higher seed yield and straw yield and biological yield. It is probably due to more dry matter production per unit area caused by better nutrient absorption from soil, increased rate of metabolic process,

Table 4. NAR (mg/dm/day) and LAD (days) as influenced by different crop establishment

Treatment	NAR (mg/dm^2/d)						LAD					
	2004-2005			2005-2006			2004-2005			2005-2006		
	30-60 DAE	60-90 DAE	90-120 DAE	30-60 DAE	60-90 DAE	90-120 DAE	30-60 DAE	60-90 DAE	90-120 DAE	30-60 DAE	60-90 DAE	90-120 DAE
T_1	37.2	60.3	13.8	39.8	63.3	14.2	39.3	46.8	24.3	41.4	50.2	26.7
T_2	41.4	71.8	16.6	44.2	73.8	17.8	43.3	51.6	27.8	45.8	54.8	31.3
T_3	34.3	58.6	10.3	37.8	60.1	11.6	35.4	41.3	20.1	39.6	45.8	22.8
T_4	30.5	52.8	8.9	33.4	55.6	10.2	32.2	37.8	17.3	36.3	42.4	19.8
T_5	32.0	55.3	9.4	35.6	58.4	11.1	34.2	38.9	19.0	37.5	45.0	21.3
T_6	28.5	48.6	8.2	30.1	50.4	9.2	30.5	35.2	115.8	33.3	37.6	18.2
CD (p=0.5)	8.3	10.2	2.6	9.8	12.2	3.4	9.2	10.6	5.8	10.1	10.9	6.6

Table 5. Yield attributing characters as influenced by different crop establishment

Treatment	Paicles/m^2			Panicle length (cm)			Panicle weight (g)			1000 grain weight (g)		
	2004 05	2005 06	pooled	2004 05	2005 06	pooled	2004 05	2005 06	pooled	2004 05	2005 06	pooled
T_1	470	482	476	19.8	20.5	20.2	2.6	2.8	2.7	20.8	21.3	21
T_2	620	636	628	21.2	21.8	21.5	3.2	3.6	3.4	21.0	21.6	21.3
T_3	455	467	461	19.2	20.1	19.7	2.7	2.5	2.6	20.6	20.1	20.4
T_4	434	448	441	18.6	19.6	19.1	2.4	2.7	2.5	19.8	20.2	20.0
T_5	445	459	452	19.0	19.9	19.5	2.2	2.5	2.3	20.0	20.4	20.2
T_6	424	438	431	18.4	19.3	18.8	2.0	2.3	2.1	19.2	19.8	19.5
CD (P=0.05)	44.2	48.3	42.6	4.2	5.4	2.9	0.4	0.2	0.1	NS	2.9	2.06

Table 6. Yield attributing characters as influenced by different crop establishment

Treatment	Spikelets/paicle			Filled spikelets/ panicle			Unfilled spikelets/ panicle			Spikelets fertility(%)		
	2004 05	2005 06	pooled	2004 05	2005 06	pooled	2004 05	2005 06	pooled	2004 05	2005 06	pooled
T_1	146.0	159.0	152.5	110	118.0	114.0	36.0	41.0	38.5	75.3	74.2	74.7
T_2	162.0	170.0	166.0	122.	130.0	126.0	40.0	40.0	40.0	75.3	76.4	75.8
T_3	138.0	151.0	144.5	101.0	109.0	105.0	37.0	42.0	39.5	73.1	72.1	72.3
T_4	129.0	137.0	133.0	103.0	95.0	99.	260	42.0	34.0	79.8	69.3	74.5
T_5	134.0	142.0	138.0	102.0	105.0	103.5	32.0	37.0	34.5	76.1	73.9	75.0
T_6	125.0	133.0	129.0	90.0	97.0	93.0	35.0	36.0	35.5	72.0	72.9	72.4
CD (P=0.05)	5.2	8.7	4.9	7.0	8.2	6.1	2.6	NS	1.06	7.2	6.9	2.1

Table 7. Grain yield, biological and harvest index as influenced by different crop establishment method

Treatment	Grain yield (t/ha)			Straw yield (t/ha)			Biological yield (t/ha)			Harvest index (%)		
	2004 05	2005 06	pooled	2004 05	2005 06	pooled	2004 05	2005 06	pooled	2004 05	2005 06	pooled
T_1	5.10	5.39	5.24	5.95	6.79	6.37	11.05	12.17	11.61	46.15	44.20	45.18
T_2	5.98	6.20	6.09	6.34	6.55	6.44	12.32	12.75	12.53	48.53	48.62	48.57
T_3	4.58	5.15	5.0	6.18	6.40	6.29	11.03	11.55	11.29	43.97	44.58	44.27
T_4	4.76	4.92	4.84	5.18	5.46	5.32	9.94	10.38	10.16	47.88	47.39	47.63
T_5	4.64	4.8	4.72	5.25	5.34	5.29	9.89	10.14	10.10	46.91	47.33	47.12
T_6	398	4.20	4.09	4.92	5.10	5.01	8.9	9.3	9.1	44.71	45.16	44.93
CD (P=0.05)	1.06	1.04	1.12	1.05	1.03	1.08	1.2	1.06	1.09	1.51	2.33	7.84

Table 8. Weed population and dry weight of weeds as influenced by different crop establishment methods

Treatment	At panicle initiation stage			At harvest			At panicle initiation stage			At harvest		
	2004 05	2005 06	pooled	2004 05	2005 06	pooled	2004 05	2005 06	pooled	2004 05	2005 06	pooled
T_1	12.2	11.68	12.16	12.90	11.97	12.44	7.39	7.0	7.20	7.68	7.25	7.47
	(159)	(136)	(147.5)	(166)	(143)	(154.5)	(54.2)	(48.6)	(51.4)	(586)	(52.2)	(55.4)
T_2	10.60	10.02	10.3	11.234	10.79	11.02	6.06	5.44	5.76	6.58	6.09	6.34
	(112)	(100)	(106)	(126)	(116)	(121)	(36.3)	(29.2)	(32.75)	(42.9)	(36.6)	(39.75)
T_3	12.74	12.32	12.48	13.50	13.13	13.32	7.72	7.40	7.56	8.04	792	798
	(162)	(149)	(155.5)	(182)	(172)	(177)	(59.2)	(54.3)	(56.75)	(64.2)	(62.3)	(63.25)
T_4	13.50	13.01	13.26	14.15	13.58	13.87	8.13	8.32	8.22	8.52	8.30	8.42
	(182)	(169)	(175.5)	(200)	(184)	(192)	(65.6)	(68.8)	(67.2)	(72.2)	(68.9)	(7.55)
T_5	13.28	13.05	13.17	14.0	14.61	14.31	7.94	8.04	7.99	8.33	8.11	8.22
	(176)	(170)	(173)	(196)	(213)	(204.5)	(62.6)	(64.3)	(63.45)	(68.9)	(65.4)	(67.15)
T_6	13.80	13.58	13.69	14.50	14.19	14.35	8.52	8.38	8.45	9.43	9.20	9.3
	(190)	(184)	(187)	(210)	(201)	(205.5)	(72.2)	(69.8)	(71.0)	(88.5)	(84.3)	(86.4)
CD (P=0.05)	10.12	13.16	11.08	12.16	14.19	13.26	5.14	6.03	4.09	7.12	6.19	5.08

rate of light absorption and increased rate of photosynthetic activity produced more number of leaves as compared to other crop establishment methods. It was closely followed by conventional method of transplanting recorded grain yield and straw yield of rice.

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EFFECT OF BIOINOCULANTS AND FYM ON GROWTH, YIELD AND QUALITY OF SOYBEAN (*Glycine max*) UNDER RAINFED CONDITIONS OF KASHMIR VALLEY

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ABSTRACT

A field experiment was conducted during kharif seasons of 2004 and 2005 to evaluate the effects of bioinoculants and farmyard manure on performance of rainfed soybean. Sole or dual inoculation of biofertilizers, application of FYM with or without biofertilizers and recommended dose of fertilizer significantly increased plant growth, grain and biological yield, total N, P and K uptake and quality of soybean over control. Application of recommended dose of fertilizer showed markedly higher growth parameters, grain and biological yield, total N, P and K uptake and quality of soybean over rest of the treatments but remain at par with *Rhizobium*+*Azotobacter*+PSB+FYM @ 5 t/ha and Rhizobium+PSB+FYM @ 5 t/ha. Among the treatments, maximum oil content in grain, oil yield and protein content and protein yield was recorded with the application of *Rhizobium*+*Azotobacter*+PSB+FYM @ 5 t/ha followed by recommended dose of fertilizer and the magnitude of increases were to the tune of 6.9, 9.7, 9.9 and 9.6% over control, respectively.

Key words : Soybean, bioinoculants, FYM, yield, uptake, quality.

Soybean [*Glycine max* (L) Merril] is one of the important oil seed as well as pulse crop grown in *kharif* season in Kaskmir valley. It occupies unique position in human diet all over the world as it contains high percentage of oil (18-22%), protein content (40-45%) and many bioactive molecules, and has also been established as industrially vital and economically sound in many parts of India. The enhancement of soil fertility assumes importance for sustained agricultural productivity in rainfed conditions. The productivity of soybean can be increased by inoculation of bio-agents such as *Rhizobium* and phosphate solubilizing microorganisms and co-inoculation of these two bio-cultures has shown encouraging results in enhancing crop productivity and improving the soil fertility (Dubey, 1997). *Azotobacter*, a free living N_2 fixer, has been applied by researchers mainly in cereals, vegetables, sugar crops etc. and proved beneficial in increasing the yield of these crops by increasing the N availability through N_2 fixation in soil. However, inoculation of *Azotobacter* with legume has not been tried so far in our soil. Organic manure, on the other side, provides a good substrate for the growth of many microorganisms and maintains a favourable nutritional balance and soil physical properties. A field experiment was, therefore, conducted to evaluate the effect of bio-inoculants along with FYM on growth, yield and quality of soybean under rainfed temperate conditions of Kashmir valley.

MATERIALS AND METHODS

A field experiment was conducted at Research Farm of Faculty of Agriculture, (SKUAST-K), Wadura, Sopore, Kashmir during *kharif* seasons of 2004 and 2005. The soil was silty clay loam with pH 7.2, organic carbon 1.01%, available N 360 kg/ha, available P 14.97 kg/ha and available K 212.8 kg/ha. The initial status of Rhizobium, Azotobacter and phosphate solubilizing bacteria (PSB) was 1.05×10^2, 1.2×10^3 and 1.7×10^3 cfu/g soils, respectively. The experiment was laid out in randomized block design with 17 treatments and replicated thrice. The plot size for each replication was 4 × 4 m. The treatment consisted of control, *Rhizobium*, *Azotobacter*, *Pseudomonas striata* (PSB), FYM @ 5 ton/ha, *Rhizobium*+ *Azotobacter*, *Rhizobium* + PSB, *Rhizobium*+FYM, *Azotobacter*+FYM, *Azotobacter*+PSB, PSB+FYM, *Rhizobium*+ *Azotobacter*+PSB, *Rhizobium*+*Azotobacter*+ FYM, *Rhizobium*+ PSB+FYM, *Azotobacter*+ PSB+FYM, *Rhizobium*+*Azotobacter*+PSB+FYM @ 5 t/ha and recommended dose of fertilizers (RDF). Farmyard manure was contained 0.65% N, 0.19% P_2O_5 and 0.68% K_2O nutrient. A uniform RDF of N, P_2O_5 and K_2O @ 20, 40 and 40 kg/ha, respectively, were applied in the form of urea, diammonium phosphate and muriate of potash only in RDF treatment. Nitrogen was applied in two equal splits, half as basal and remaining half as top dressing at 30 days after sowing and full dose of P_2O_5 and K_2O was applied as basal except in control. Inoculations of *Bradyrhizobium japonicum*, *Azotobacter chroococcum*, *Pseudomonas striata* (PSB) were done through seed @ 500 g/ ha. For this, slurry of carrier-based (charcoal) culture was prepared in sterilized (20%) gur solution and soybean seed (VL Soya) were treated single or mixed cultures of bioinoculants as per treatments, dried in shade and sown immediately..The charcoal based cultures of *Bradyrhizobium japonicum* (3.9 x 10^7 cfu/g), *Azotobacter chroococcum* (2.3 x 10^7 cfu/g) and *Pseudomonas striata* (1.8 x 10^7 cfu/g) were procured from Regional Research Laboratory, CSIR, Jammu. The crop was sown on 16 June, 2004 and 09 June, 2005 and harvested on 21 October, 2004 and 16 October, 2005. All the cultural practices were followed as per the package of practices. The yield data for grain and straw for all plots were collected at the end of the experimentation. Oil content was estimated by water and steam distillation methods using Clevenger's type essential oil apparatus. Processed seed samples were digested and N was determined by micro kjeldahl methods as advocated by Piper (1966). Protein content was calculated by multiplying N content by the factor 5.8. The oil and protein yield (kg/ ha) was computed by multiplying it with seed yield (q/ha) and dividing by 100.

RESULTS AND DISCUSSION

Growth parameters

Inoculation of bioinoculants, FYM and RDF alone or in combination significantly improved plant height, fresh weight, root and shoot dry weight and number of branches/plant over control, except inoculation with Azotobacter alone. Maximum increases were noticed under RDF followed by application of Rhizobium+Azotobacter+PSB+FYM @ 5 t/ha and *Rhizobium*+ PSB+FYM @ 5 t/ha which were significantly higher over rest of the treatments (Table 1). Sole inoculation of Rhizobium showed its superiority to phosphate-solubilizing bacteria and FYM @ 5 t/ha in respect of growth parameters. The increases in plant growth might be attributed to effective symbiosis in soybean and increased biological N fixation by *Rhizobium*, greater release of P by phosphate-solubilizing bacteria and release of growth promoting hormones and vitamins by Azotobacter might have favoured the plant growth characters (Baskar *et al.*, 2000).

Grain and biological yield

The application of RDF, being on par with *Rhizobium*+*Azotobacter*+PSB+FYM @ 5 t/h and *Rhizobium*+PSB+FYM @ 5 t/ha registered markedly higher value of grain and biological yield which were to the tune of 1.70, 4.13, 1.65, 4.05 and 1.61 and 3.98 t/ha (pooled basis), respectively, over rest of the treatments (Table 1). The enhanced effects of *Rhizobium, Azotobacter*, phosphate solubilizing bacteria indicating their synergistic action among them and increased efficacy in the presence of FYM used as sources of carbon (Mel'nikova *et al.*, 2002). The improvement in grain and biological yield over untreated control was 46.6, 45.9, 42.2, 43.1, 38.8 and 40.6% under RDF, *Rhizobium*+ *Azotobacter* +PSB+FYM @ 5 t/h and *Rhizobium*+ PSB+FYM @ 5 t/h, respectively. Further, sole inoculation of *Rhizobium* and phosphate solubilizing bacteria registered 19.8, 17.3, 11.2 and 11.7% increase in grain and biological yield over uninoculated control, respectively. Harvest index was recorded maximum with combined application of PSB+FYM @ 5 t/ha (42.49%) followed by *Rhizobium*+*Azotobacter* (42.21%) and *Rhizobium* (41.87%) whereas minimum with *Azotobacter*+ FYM (40.31%). Similar results were also reported by Dubey (1997).

Nutrient uptake

Single inoculation of *Azotobacter* failed to enhance total N, P and K uptake while sole inoculation with *Rhizobium*, PSB and FYM application @ 5 t/ha significantly enhanced the total N, P and K uptake. On the other hand dual as well as multi-inoculation of biofertilizers with or without FYM statistically increased the total N, P and K uptake by soybean (Table 1). Application of *Rhizobium*+ *Azotobacter*+ PSB+FYM @ 5 t/ha being at par with RDF and *Rhizobium*+PSB+FYM @ 5 t/ha recorded significantly higher total uptake of N, P and K over rest of the treatments. The per cent increase in total nutrient uptake over control was 44.1, 45.2 and 42.5% under RDF, Rhizobium+ *Azotobacter*+PSB+FYM @ 5 t/ha and *Rhizobium*+PSB+FYM @ 5 t/ha, respectively. Further, sole inoculation of *Rhizobium*, phosphate solubilizing bacteria and application of FYM registered 17.9, 9.9 and 13.6% increase in total N, P and K uptake over uninoculated control, respectively. The resultant increase in total NPK uptake might be attributed to more biological N fixation by *Rhizobium* and *Azotobacter*, N-assimilation and increased availability of P in soil due to greater solubilization of insoluble phosphate compounds by phosphate solubilizing bacteria and also release of mineral N, P and K from FYM (Sarawgi *et al.*, 1998).

Quality attributes of soybean

Bioinoculants inoculation alone or in combination with or without FYM and application of RDF improved the quality of soybean (Table 2). Application of *Rhizobium*+*Azotobacter*+PSB+FYM @ 5 t/ha recorded maximum oil and protein content whereas oil and protein yield observed maximum with RDF being at par with combined inoculation of *Rhizobium*+*Azotobacter*+PSB+FYM @ 5 t/ha but significantly higher over rest of the treatments. Inoculation of *Azotobacter* and PSB alone did not enhance significant oil and protein content over the control. However, oil and protein yield enhanced significantly. The improvement in oil content and oil yield over control was 6.7, 56.3, 6.9 and 52.0% with RDF and *Rhizobium*+*Azotobacter*+PSB+FYM @ 5 t/ha.

Table 1. Effect of bioinoculants and FYM on growth (at 70 DAS), yield and total N, P and K uptake by soybean (average data of 2 years)

Treatment	Plant height (cm)	Fresh weight (g/plant)	Root dry weight (g/plat)	Shoot dry weight (g/plat)	Branches/ plant	Grain yield (t/ha)	Biological yield (t/ha)	H.I. (%)	Total NPK uptake (kg/ha)
Control	53.6	45.49	0.74	10.86	5.02	1.16	2.83	40.99	176.6
Rhizobium	65.2	72.61	1.10	14.70	6.78	1.39	3.32	41.87	208.3
Azotobacter	58.2	48.56	0.81	11.19	5.29	1.23	2.98	41.28	187.2
PSB	59.2	63.79	0.86	12.54	5.48	1.29	3.16	40.82	194.0
FYM@ 5 t/ha	63.0	68.80	0.90	12.70	5.93	1.30	3.18	40.88	200.7
Rhiz+Azot	68.0	77.53	1.08	14.72	6.83	1.41	3.34	42.21	215.4
Rhiz+PSB	68.7	82.26	1.17	15.13	7.41	1.46	3.51	41.60	224.2
Rhiz+FYM	68.9	83.67	1.25	15.65	7.58	1.52	3.64	41.76	233.7
Azot+FYM	63.7	70.32	1.08	14.32	6.41	1.31	3.25	40.31	210.1
Azot+PSB	63.6	68.75	0.95	13.65	6.20	1.30	3.18	40.88	198.9
PSB+FYM	65.4	74.62	1.04	14.56	7.45	1.47	3.46	42.49	211.6
Rhiz+Azot+PSB	72.9	90.39	1.22	18.48	7.54	1.49	3.66	40.71	224.4
Rhiz+Azot+FYM	79.3	114.76	1.37	19.23	7.88	1.59	3.87	41.09	243.1
Rhiz+PSB+FYM	82.2	129.2	1.55	20.95	8.46	1.61	3.98	40.45	251.6
Azot+PSB+FYM	70.3	88.03	1.20	17.20	7.49	1.48	3.61	41.00	226.0
Rhiz+Azot+PSB+FYM	84.4	131.06	1.59	21.01	8.60	1.65	4.05	40.74	256.5
100% RDF	84.3	131.70	1.64	21.56	8.80	1.70	4.13	41.16	254.5
Sem$_{\pm}$	1.72	1.89	0.03	0.56	0.15	0.40	0.10	0.07	4.72
CD (P=0.05)	4.78	4.29	0.09	1.58	0.40	0.11	0.29	0.20	13.05

Rhiz= *Rhizobium*, Azot= *Azotobacter*, PSB= *Pseudomonas striata*, FYM=Farm yard manure

Table 2. Effect of bioinoculants and FYM on quality of soybean (average data of 2 years)

Treatment	Oil content in grain (%)	Oil yield (kg/ha)	Protein content in grain (%)	Protein yield (kg/ha)
Control	17.08	198.1	37.28	432.4
Rhizobium	17.36	241.3	38.93	541.1
Azotobacter	17.15	211.0	38.45	472.9
PSB	17.24	221.9	38.65	498.6
FYM@ 5 t/ha	17.29	224.8	38.77	504.0
Rhiz+*Azot*	17.42	245.3	39.07	550.5
Rhiz+PSB	17.77	259.4	39.82	581.4
Rhiz+FYM	17.96	273.0	39.31	612.7
Azot+FYM	17.33	227.0	38.86	509.1
Azot+PSB	17.27	224.0	38.72	503.4
PSB+FYM	17.82	261.9	39.99	587.9
Rhiz+*Azot*+PSB	17.88	266.4	40.12	597.8
Rhiz+*Azot*+FYM	18.02	286.5	40.45	643.2
Rhiz+PSB+FYM	18.17	292.5	40.70	655.3
Azot+PSB+FYM	17.85	264.2	40.10	593.5
Rhiz+*Azot*+PSB+FYM	18.25	301.1	40.98	676.2
100% RDF	18.22	309.7	40.86	694.6
Sem±	0.09	4.70	0.53	10.62
CD (P=0.05)	0.24	12.89	1.46	29.10

Rhiz= Rhizobium, Azot= *Azotobacter*, PSB= *Pseudomonas striata*, FYM=Farm yard manure

Similarly, per cent increase in protein content and protein yield over control was 9.6, 60.6, 9.9 and 56.4% with RDF and *Rhizobium*+ *Azotobacter*+PSB+FYM @ 5 t/ha, respectively. Further, sole inoculation of *Rhizobium* and phosphate solubilizing bacteria registered 21.8, 12.0, 25.1 and 15.3% increase in oil and protein yield over uninoculated control, respectively. This might be due to increased nitrogen uptake by soybean seed which increased protein and oil contents. Similar findings were also reported by Tanwar and Shaktawat (2003).

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EFFECT OF INTEGRATED USE OF FERTILIZERS, ORGANIC MANURES AND MICRONUTRIENTS ON PRODUCTIVITY OF SESAME (*SESAMUM INDICUM*)

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ABSTRACT

An experiment was conducted during 2006 and 2007 on clay loam soil during kharif season under All India Coordinated Research Project on Sesame at Tikamgarh to study the effect of inorganic fertilizer, organic manures and micronutrients on growth, yield and economics of sesame. The seed yield was significantly increased with integrated use of 100% NPK + 2.5 t FYM + ZnSO4 + $FeSO_4$ as compared to inorganic fertilizer alone (13.09 %) or with FYM (16.54 %) or with oil cake (11.45 %). The highest gross return was obtained with the application of 100% NPK + 2.5 t FYM + $ZnSO_4$ + $FeSO_4$ whereas highest net return was obtained under 100% NPK + 2.5 t FYM + $FeSO_4$. The highest productivity and return was obtained through recommended dose of fertilizer alongwith FYM, $ZnSO_4$ and $FeSO_4$ indicated that NPK fertilizers alone did not provide adequate and balanced nutrition to realize the potential of the crop.

Key words : Economics, nicronutrients, sesame, yield.

Sesame is an ancient and important oil crop of India. As sesame is cultivated on marginal and sub-marginal lands with poor fertility, under rainfed conditions without any nutrients management resulted low productivity, around 350 kg/ha (Duhoon *et al.* 2002). Intensive agriculture and continuous use of macronutrients level lead to heavy removal of micronutrients resulting in deterioration of soil health and ultimately reduction in crop yield in spite of improvement in crop production technology. Organic manures have great significance in maintaining the soil health and ultimately the soil productivity. Sulphur has been found to be major limiting factor in oilseed production. Sesame like other crops, grows and produce well only when it receives an adequate and balanced supply of macro and micronutrients integrated with organics like farmyard manures, oilcakes etc. Adequate manuring not only improves the crop yield but also sustains the soil health and productivity (Jain and Sharma, 2000). Hence, an attempt was made to study the effect of inorganic fertilizer, organic manures and micronutrients on growth, yield and economics of sesame.

MATERIALS AND METHODS

The studies were carried out during *kharif* season of 2006 and 2007 in rainfed conditions under All India Co-coordinated Project on Sesame at Tikamgarh (M.P.). The experiment was laid out in randomized block design replicated four times with twelve treatments viz, 100 % RDF (recommended dose of fertilizer, 60:40:20 NPK kg/ha), 50 % RDF, 100 % RDF + 2.5 t FYM/ha, 50 % RDF + 2.5 t FYM/ha, 100 % RDF + 0.5 t non edible cake/ha, 50 % RDF + 0.5 t non edible cake/ha, 100 % RDF + 2.5 t FYM/ha + ZnSO4 @ 20 kg/ha, 100% RDF + 2.5 t FYM/ha + FeSO4 @ 25 kg/ha, 100% RDF + 2.5 t FYM/ha + ZnSO4 @ 20 kg/ha+ FeSO4 @ 25 kg/ha, 50% RDF + 2.5 t FYM/ha + ZnSO4 @ 20 kg/ha, 50% RDF + 2.5 t FYM/ha + FeSO4 @ 25 kg/ha and 50% RDF + 2.5 t FYM/ha + $ZnSO_4$ @ 20 kg/ha + $FeSO_4$ @ 25 kg/ha in four replications. The soil of the experimental field was clay loam in texture. The soil was low in available N (165 kg/ha), medium in available P (12.3 kg/ha) and high in available K (443 kg/ha). Sesame variety JTS-8 was sown with a spacing of 30 x 10 cm during both the years.

Growth parameters viz, plant height and number of branches per plant was recorded at 70 DAS and yield attributes *viz*, number of capsules/plant, number of seeds/capsule and test weight was recorded at harvest. The economics of each treatment was calculated for the pooled data of the two years to judge the profitability of the treatment taking into account of all the component of cost of cultivation included in all the treatments.

RESULTS AND DISCUSSION

Growth and yield attributes

Observations on plant height and branches were recorded at 70 days after sowing were significantly influenced by various treatments (Table 1). Tallest plants of 113.75 cm were observed with 100% RDF + 2.5 t FYM/ha + $ZnSO_4$ @ 20 kg/ha + FeSO4 @ 25 kg/ha followed by 100% RDF + 2.5 t FYM/ha + ZnSO4 @ 20 kg/ha (112.25 cm), 100% RDF + 2.5 t FYM/ha + $FeSO_4$ @ 25 kg/ha (110.75 cm) and 100% RDF + 2.5 t FYM/ha (109.75 cm). The number of branches were maximum with 100% RDF + 2.5 t FYM/ha + $ZnSO_4$ @ 20 kg/ha + $FeSO_4$ @ 25 kg/ha (4.45) and were statistically at par with 100% RDF + 2.5 t FYM/ha + $FeSO_4$ @ 25 kg/ha (4.33), 100% RDF + 2.5 t FYM/ha + $ZnSO_4$ @ 20 kg/ha (4.30) and 100% RDF + 0.5 t non edible cake/ha (4.08).

Yield attributes were also significantly influenced by nutrient sources. No remarkable difference was observed on number of capsules/plant and number of seeds/capsule in the treatment receiving 50 % RDF + 2.5 t FYM/ha, 50 % RDF + 2.5 t FYM/ha + $ZnSO_4$ @ 20 kg/ha or FeSO4 @ 25 kg/ha or both however, it was significantly superior over 50 % RDF alone. Alone application of RDF 50% or 100% was found

Table 1. Effect of fertilizers, organic materials and micronutrients on plant growth and yield attributes of sesame

Treatments	Plant Height	No. of branches/ plant	No. of pods/ plant	No. of seeds/ pod	Test weight
Recommended dose of fertilizer (RDF) (60:40:20 NPK kg/ha)	107.75	3.85	30.95	53.95	2.66
50% RDF	98.25	3.00	22.90	44.20	2.38
100% RDF+2.5 t FYM/ha	109.75	3.95	33.35	54.28	2.80
50% RDF+2.5 t FYM/ha	102.75	3.35	26.80	49.15	2.48
100% RDF+0.5 t non edible cake/ha	110.00	4.08	31.25	53.80	2.72
50% RDF+ t non edible cake/ha	103.00	3.85	28.60	52.50	2.68
100% RDF+2.5 t FYM/ha+ZnSO4 20 kg/ha	112.25	4.30	34.20	54.60	2.81
100% RDF+2.5t FYM/ha+ZnSO4 25 kg/ha	110.75	4.33	34.15	54.40	2.70
50% RDF+2.5t FYM 20 kg/ha+FeSO4 25 kg/ha	113.75	4.45	39.75	56.10	2.88
50% RDF+2.5 t FYM /ha+ZnSO4 20 kg/ha	105.75	3.75	29.80	50.70	2:60
50% RDF+2.5 t FYM /ha+FYM/ha+ZnSO20 kg/ha	106.00	3.78	32.2	50.88	2.68
50% RDF+2.5 t FYM /ha+ZnSO4 20 kg/ha +FeSO4 25 kg/ha	105.75	3.70	30.85	80.90	2.65
SEm±	2.42	0.18	2.10	1.42	0.10
C.D. (p=0.05)	7.89	0.59	6.85	4.62	0.31

Table 2. Effect of fertilizers, organic materials and micronutrients on plant growth and yield attributes of sesame

Treatments	Seed yield (kg/ha)			Cost of cultivation	Net return (Rs/ha)	B:C ratio
	2006	2007	Mean			
Recommended dose of fertilizer (RDF) (60:40:20 NPK kg/ha)	802	281	542	6850	8602	2.26
50% RDF	661	219	440	6150	6259	2.02
100% RDF+2.5 t FYM/ha	750	302	526	7350	8077	2.10
50% RDF+2.5 t FYM/ha	710	240	475	6650	6795	2.02
100% RDF+0.5 t non edible cake/ha	809	292	550	8850	6936	1.78
50% RDF+ t non edible cake/ha	814	293	539	8150	6973	1.86
100% RDF+2.5 t FYM/ha+ZnSO4 20 kg/ha	833	314	573	8110	8475	2.05
100% RDF+2.5t FYM/ha+FeSO4 25 kg/ha	859	315	587	8250	8647	2.05
100% RDF+2.5tFYM ZnSO4 20 kg/ha+FeSO4 25 kg/ha	906	320	613	9010	8511	1.95
50% RDF+2.5 t FYM /ha+FenSO4 20 kg/ha	765	260	513	7410	7133	1.96
50% RDF+2.5 t FYM /ha+ FeSO4 25 kg/ha	765	263	514	7550	7058	1.94
50% RDF+2.5 t FYM /ha+ZnSO4 20 kg/ha +FeSO4 25 kg/ha	765	271	518	8310	6493	1.76
SEm±	31.44	11.38				
CD (p=0.05)	72.62	33.00				

inferior than the combined use of inorganic and organic sources. Maximum number of capsules and number of seeds/ capsule was recorded under 100% RDF + 2.5 t FYM/ha + $ZnSO_4$ @ 20 kg/ha+ $FeSO_4$ @ 25 kg/ha and followed the same trend as in number of branches/plant. The test weight also followed the similar trend. The increase in these growth parameters and yield attributes was the result of continuous supply of nutrient from conjunctive use of organic and inorganic source of nutrient (Panwar *et al.* 2001). In addition, response of micronutrient and sulphur application through $FeSO_4$ or $ZnSO_4$ or both with recommended dose of fertilizer and 2.5 t FYM/ha significantly increased the growth parameters. The higher yield with sulphur application may be ascribed to better nutrient availability of treated soils because sulphur application improves the soil physical conditions. (Nabi *et al.*, 1990).

Yield

Yield performance of sesame varied significantly with different nutrient management treatments (Table 2). The significantly higher seed yield was recorded under 100% RDF + 2.5 t FYM/ha + ZnSO4 20 kg/ha+ FeSO4 25 kg/ha (906 and 320 kg/ha) followed by 100% RDF + 2.5 t FYM/ha + $ZnSO_4$ @ 20 kg/ha (859 and 315 kg/ha) and 100% RDF + 2.5 t FYM/ha + FeSO4 @ 25 kg/ha (833 and 314 kg/ha) during both the years. Application of 2.5 t FYM/ha alongwith RDF reduced the yield of sesame during first year but increased during second year although the difference was non significant during both the years over RDF alone. Response of non edible cake with RDF either with 50% or 100 % was not marked and it was at par with RDF 100 % alone. The effect of 50 % RDF alongwith FYM, $ZnSO_4$ and FeSO4 was significantly lower than their integration with 100% RDF. The significantly lowest yield was recorded under 50% RDF alone (661 and 219 kg/ha) during both the years.

Economics

The cost of cultivation (Rs. 9010/ha) and gross monetary return (Rs. 17521/ha) was highest under T9 (Table 2). However, net monetary return was highest in T8 (Rs. 8647/ha) followed by T1 (Rs. 8602/ha). Application of recommended dose of fertilizer 100 % was more remunerative with higher B:C ratio (2.26) followed by 100% RDF + 2.5 t FYM/ha (2.10) due to lower cost of cultivation.

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YIELD, UPTAKE AND QUALITY OF INTERCROP AS INFLUENCED BY INTERCROPPING RATIOS OF NIGER IN *KHARIF* VARI (*PANICUM MILIACEUM* L.) WITH ORGANIC AND INORGANIC SOURCES OF NUTRIENTS

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Abstract

Field experiment conducted at Dapoli revealed that, niger is more remunerative intercrop in proso millet, as it enhanced the growth and yield of proso millet. The recorded 3:1 row ratio with the application of inorganic sources of nutrients higher yields. Results also revealed that in case of sole crop, uptake of nitrogen, phosphorus and potassium was higher under proso millet than niger. In case of intercropping, higher total nitrogen uptake was observed in proso millet + niger in 1:2 row ratio. Similarly, total phosphorus and potassium uptake was higher in proso millet + niger intercropping in 3:1 row ratio.

Key words : Proso millet, niger, intercropping, sources of nutrients, nutrients uptake.

Intercropping system is an age old practice of growing simultaneously two or more crops in the same piece of land at the same time or in the same season. It has been a common practice followed by the farmers of India, Africa, Sri Lanka and West Indies. The basic idea of intercropping is not only that two or more crop species grown together can exploit the resources better than either of them grown separately, but also that the inherent risk in agriculture and more so, under dry land conditions are buffered to some extent called as "biological insurance" (Ayyer, 1963).

Aiyer (1949) reported that the resources with regard to the plant nutrients present in the soil or added to it as manure were utilized to the fullest extent in mixed stand than when components were grown separately. The different crops having varying root depths extract moisture and nutrients from different soil layers. The periodical income and distribution of labour requirement throughout the year is of great help to poor cultivators.

Efficient utilization of nutrient, moisture, space and solar energy can be derived through mixed or intercropping system (Ayyer, 1963; and Francis and Heichel, 1973). Yield advantages in intercropping system are mainly because of differential use of growth resources by the component crop. The main way of complimentarity occur when the growth pattern of component crop differ in time. The yield advantage in intercropping system is associated with efficient use of environmental resources over time (Willey *et al.*, 1985).

MATERIALS AND METHODS

A field experiment was conducted at the Agronomy Farm of Dr. B.S.K.K.V. Dapoli Maharashtra during the *kharif* season of 2007-2008, on red lateritic soil of Konkan region. The farm is located in tropical region on 17° N latitude and 73° E longitude at an elevation of 250 meter above the mean sea level. The variety used were Vari No. 10 and JNC-6 for proso millet and niger, respectively. The treatments consisted of five row ratios (1:1, 2:1, 3:1, 1:2, 1:3) along with sole crop of proso millet and niger, and two sources of nutrient i.e. organic (5 t/ha through FYM and inorganic (50% of recommended N and 100 % of P + K through complex (19:19:19) and remaining 50 % N top dressed through urea. There were 14 treatment combinations replicated thrice in randomized block design. The plot size was 4.8 X 3.6 meter. Seed rates were 5 and 3 kg/ ha for both the crops respectively. The crop was raised using all recommended agronomic practices.

Line sowing of proso millet was done in nursery with well prepared raised bed of size 5X 1 meter. After 15 days 1 kg N for 100 sq. m. areas was given, and transplanting was done after 20 days on main plot leaving rows for niger sowing. On the same day niger was sown in line in main plots. During the period of experiment, total rainfall of 4260 mm was received from June to October. Growth, yield attributes and yield were observed and based on these characters the most efficient intercropping was evaluated.

RESULTS AND DISCUSSION

Yield

Grain yield of sole proso millet was significantly higher than their respective intercrop ratios of 1:1, 2:1, 1:2 and 1:3. The proso millet + niger in 3:1 row ratio was found at par with sole proso millet and these treatments were significantly higher than rest of the treatments. Grain yield of proso millet was found higher due to application of inorganic sources of nutrient over the application of organic source of nutrient. Straw yield of proso millet was higher in sole crop. Among the intercroppings, proso millet + niger in 3:1 row ratio was found at par with sole proso millet followed by 2:1 row ratio. Similar trends were found in case of harvest index as compared to grain yield. Similar results were earlier reported by Mahadkar and Khanvilkar 1988, Maitra *et al.* (2001).

Niger yield was statistically affected due to different row ratios. Significantly higher yield of niger was recorded under sole crop. Among the intercropping systems proso millet + niger in 1:3 row ratio recorded significantly higher yield followed by proso millet + niger in 1:2 row ratio over rest of the treatments. Yield was found to be increased due to inorganic sources of nutrients over organic source of nutrient. Yield of straw per hectare was statistically affected due to row ratios. Significantly higher yield of straw

Table 1. Yield and quality of prosomillet and niger as affected by different treatments

Treatment	Grain yield (q/ha)		Straw yield (q/ha)		Protein (kg/ha)	
	Main crop	Intercrop	Main crop	Intercrop	Main crop	Intercrop
Sole Proso millet	12.52	-	68.17	-	78.81	-
Sole niger	-	4.38	-	46.13	-	79.03
Proso millet + Niger 1:1	7.76	2.30	56.77	21.57	46.34	42.67
Proso millet + Niger 2:1	8.67	2.01	61.20	18.18	60.21	30.90
Proso millet + Niger 3:1	11.20	1.80	66.02	15.20	72.45	27.38
Proso millet + Niger 1:2	8.16	3.29	54.25	26.67	39.59	55.88
Proso millet + Niger 1:3	4.90	4.12	38.65	29.95	30.18	70.66
S.E m ±	0.66	0.06	3.16	0.72	2.88	1.35
CD at 5%	1.94	0.17	9.26	1.10	8.43	3.96
Sources of nutrients						
Organic	7.89	2.53	55.24	23.68	43.82	3.96
Inorganic	9.88	3.43	59.79	28.89	65.38	59.80
SE m ±	0.38	0.03	1.82	0.41	1.66	0.78
CD at 5%	NS	0.10	NS	NS	4.87	NS

was recorded under sole niger crop. Among the intercropping systems, proso millet + niger in 1:3 row ratio recorded significantly higher yield of straw followed by 1:2 row ratio over rest of the treatments. Similar findings were earlier reported by Reddy *et al.*, 1983 and Thorat *et al.* (1986).

Protein yield

Sole proso millet recorded the highest protein yield. Among the intercropping treatments proso millet + niger in 3:1 row ratio recorded significantly higher protein yield over remaining treatments. Protein yield in niger grain was found statistically affected due to different row ratios. Among the intercropping treatments proso millet + niger in 1:3 row ratio recorded significantly higher protein yield over remaining treatments. Similar results were earlier reported by More (1990).

Protein yield in proso millet and niger was increased due to application of inorganic sources of nutrients over the application of organic source of nutrient.

Interaction effect of row ratios and sources of nutrients on protein yield of proso millet was significant and was more in sole proso millet, when applied with inorganic sources of nutrients. Effect of interaction on yield of protein in niger crop was not significant.

Maximum total uptake of nitrogen was recorded under proso millet + niger in 1:2 row ratio, i.e. 80.39 kg/ha and minimum total uptake of nitrogen was recorded under proso millet + niger in 1:3 row ratio. In all intercropping systems, the total nitrogen uptake was more than the sole proso millet except proso millet + niger in 1:3 row ratio. Among the intercroppings, proso millet + niger in 1:2 row ratio recorded higher total nitrogen uptake followed by 3:1, 2:1 and 1:1 row ratios, respectively.

Maximum total uptake of phosphorus was recorded under proso millet + niger in 3:1 row ratio i.e. 18.32 kg/ha and minimum total uptake of phosphorus under proso millet + niger in 1:1 row ratio i.e. 13.83 kg/ha.

Table 2. Uptake of N, P and K (kg/ha) intercropping systems as affected by different treatments

Treatment	Nitrogen			Phosphorus			Potassium		
	Main crop	Intercrop	Total	Main crop	Intercrop	Total	Main crop	Intercrop	Total
Sole Proso millet	69.88		69.88	12.88	-	12.88	120.12	-	120.12
Sole niger	-	49.46	49.46	-	6.93	6.93	-	72.04	72.04
Proso millet + Niger 1:1	53.58	19.93	73.51	10.01	3.82	13.83	109.66	27.97	137.63
Proso millet + Niger 2:1	56.65	17.22	73.87	11.33	3.97	15.3	96.43	21.84	118.27
Proso millet + Niger 3:1	59.86	14.28	74.14	14.4	3.92	18.32	127.8	18.92	146.72
Proso millet + Niger 1:2	45.28	35.11	80.39	10.21	4.94	15.15	73.23	34.82	108.05
Proso millet + Niger 1:3	22.03	43.2	65.23	7.84	5.99	13.83	85.41	36.68	122.09

Among the intercroppings, proso millet + niger in 3:1 row ratio recorded higher total phosphorus uptake, followed by proso millet + niger in 1:2 row ratio.

Maximum total uptake of potassium was recorded under proso millet + niger in 3:1 row ratio i.e. 146.72 kg/ha[1] and minimum total uptake of potassium recorded under sole niger i.e. 72.04 kg/ha. Among the intercropping systems, proso millet + niger in 3:1 and 1:1 row ratios recorded higher uptake than 2:1, 1:2 and 1:3 row ratios, respectively. Smilar findings were earlier reported by Siddeswaran *et al.* (1989).

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DIFFERENCES IN NITROGEN AND SULPHUR UPTAKE IN CANOLA AND NON CANOLA CULTIVARS OF OILSEED RAPE (*BRASSICA NAPUS* L.) AS INFLUENCED BY APPLICATION TIME OF NITROGEN AND SULPHUR

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Abstract

The effect of time of application of nitrogen (N) and sulphur (S) on nutrient uptake by three cultivars of oilseed rape (*Brassica napus* L.) was studied at Punjab Agricultural University Ludhiana during *rabi* 2006-07. Non canola cultivar GSL 1 recorded significantly higher nitrite reductase activity and higher nitrate reductase activity than both canola cultivars whereas opposite trend was discerned for nitrate reductase activity at 80 DAS. The differences among cultivars for N and S content at any growth stage were non significant. However, N and S uptake by seed was highest in OCN 3 and lowest in GSL 1. Combined application of N and S resulted in significantly higher nitrite reductase activity at 50 and 80 DAS and nitrate reductase activity at 50 DAS compared to their application alone or without application of N and S. The highest N uptake at all growth stages (except 50 DAS), seed and stover at harvest was registered with split application of N and S ($N_{50+50}S_{20+20}$). Both N and S applied in two equal splits ($N_{50+50}S_{20+20}$) registered higher S content and significantly higher S uptake at all growth stages, seed and stover than application of same quantity of N in two equal splits and S only at sowing or their application in three splits.

Key words : Canola, nitrogen, sulphur, time of application, enzyme activity, content, uptake.

Cruciferae (*Brassicas*) crops require higher amount of sulphur in addition to nitrogen for their optimum growth, yield and oil formation than other crops. These nutrients have greater synergistic effect and therefore simultaneous availability of optimum amounts of these nutrients at different growth stages helps in amino acid synthesis and other primary metabolic functions. Oilseed rape (*Brassica napus* L.) is an important oil crop of temperate regions. Its cultivation is spreading under irrigated conditions of north India due to its frost tolerance, high yield potential and higher oil content and its immunity to white rust as compared to Indian mustard (*Brassica juncea* L.). Understanding of plant's ability to take up remobilize nutrients to sink during growth cycle is required to optimize nutrient needs of crop at different growth stages. Influence of late application of nitrogen (N) and sulphur (S) on recently released canola cultivars of oilseed rape is not known. The present investigation was therefore conducted to study the effect of time of application of N and S on their nutrient uptake during crop growth of canola vis-à-vis non canola cultivars of oilseed rape.

Materials and Methods

The field investigation was carried out at the Punjab Agricultural University Ludhiana during *rabi* 2006-07 to study the effect of time of application of nitrogen and sulphur on nutrient uptake by three cultivars of oilseed rape. The soil of the experimental field was loamy sand, low in available nitrogen, medium in available phosphorus and rich in available potassium and medium in available sulphur. The study was conducted in split plot design in three replications with two canola (GSC 5 and OCN 3) and one non canola (GSL 1) cultivars in main plots and eight treatments of time of application of N (100 kg/ha) and S (40 kg/ha) *viz;* N_0S_0, N_0S_{40}, $N_{50+50}S_0$, $N_{50+50}S_{40}$, $N_{0+50}S_{20+20}$, $N_{50+25+25}S_{20+10+10}$, $N_{25+50+25}S_{10+20+10}$, $N_{34+33+33}S_{14+13+13}$ in sub plots. The crop was sown on 28 October 2006 at row spacing of 45 cm in a gross plot size of 5.0m x 3.6m. diaammonium phosphate was drilled at sowing to supply 30 kg P_2O_5 /ha and part of the basal dose of nitrogen. Remaining nitrogen and sulphur were applied in the form of urea and gypsum respectively at sowing, sowing and vegetative stage or sowing, vegetative and 50% flowering stages as per treatments.

For accumulation of dry matter, plants were harvested from 0.5 metre length of the outer row in each treatment. Nitrite reductase activity (NIR, EC-1 .7.7.1) as proposed by Verner and Ferari (1971) and nitrate reductase activity (NR, EC- 1.6.6.1) as per the method of Jaworski (1971) were determined at 50 and 80 days after sowing (DAS) whereas N (Hesse, 1971) and S (Chesnin and Yien, 1951) content and their uptake were determined at 50, 80 and 110 DAS as well as in seed and stover at harvest.

RESULTS AND DISCUSSION

Enzyme activity

Activity of nitrite reductase and nitrate reductase enzymes was determined at 50 and 80 days after sowing (DAS) which coincided with the pre flowering stage of canola (OCN 3 and GSC 5) and non canola (GSL 1), respectively. The activity of both enzymes was higher at 80 than 50 DAS (Table 1). The study revealed that at 50 DAS, GSL 1 recorded significantly higher nitrite reductase activity and higher nitrate reductase activity than both canola cultivars whereas opposite trend was discerned for nitrate reductase activity at 80 DAS (Table 1). Higher enzyme activity indicated efficient photosynthesis and N metabolism. Earlier Siddiqui and Mohammad (2004) recorded higher nitrate reductase activity in canola oilseed rape than cultivars of Indian mustard Combined application of nitrogen (N) and sulphur (S) resulted in significantly higher nitrite reductase activity at 50 and 80 DAS and nitrate reductase activity at 50 DAS compared to their application alone or without application of N and S (Table 1). Application of N alone also registered significantly higher activity of nitrite reductase at 50 DAS and nitrate reductase enzymes at both stages than control. Nitrate reductase being the first enzyme in the nitrate metabolism of plants

Table 1. Differences of cultivars of oilseed rape and influence of doses and time of application of nitrogen and sulphur on the nitrate reductase ad nitrate reductase activity at two growth stages

Tratments	Nitrite reductase (m mole NO_2/g tissue fresh weight)		Nitrate reductase m mole of NO_3/g tissue fresh weight)	
	50 DAS	80 DAS	50 DAS	80 DAS
Cultivars				
OCN 3	0.21	0.41	0.19	0.24
GSC 5	0.20	0.41	0.19	0.25
GSL 1	0.23	0.35	0.21	0.22
CD at 5%	0.01	0.04	NS	0.02
Application of nutrients (kg/ha)				
N_0S_0	0.14	0.34	0.15	0.19
N_0S_{40}	0.20	0.40	0.15	0.19
$N_{50+50}S_0$	0.20	0.40	0.20	0.24
$N_{50+50}S_{40}$	0.26	0.38	0.24	0.27
$N_{50+50}S_{20+20}$	0.26	0.40	0.23	0.26
$N_{50+25+25}S_{20+10+10}$	0.23	0.49	0.23	0.25
$N_{34+33+33S14+13+13}$	0.22	0.38	0.20	0.25
$N_{25+50+25S10+20+10}$	0.22	0.46	0.22	0.25
CD at 5%	NS	NS	0.03	0.03

DAS: Days after sowing

before its assimilation to protein indicates the N requirements of the plants. Higher nitrate reductase activity with 100 kg N+40kg S/ha indicates role of balanced application of N and S in nitrogen assimilation. Higher nitrate reductase activity in *Brassica campestris* and *Brassica juncea* with 100 kg N + 40 kg S/ha compared to 100 kg N/ha alone was earlier reported by Ahmad *et al.* (2001).

Nutrient content and uptake

A perusal of periodic data reveals that there was progressive decline in N and S content with advancing age of plants (Tables 2 and 3). The differences among cultivars for N and S content at any growth stage were non significant though GSC 5 registered highest N content throughout crop growth period. GSL 1 registered significantly higher N and S ,uptake than both canola cultivars at all growth stages and in stover at harvest (Tables 2 and 3). Total N and S uptake followed the pattern of dry matter accumulation However, N and S uptake by seed was highest in OCN 3 and lowest in GSL 1. Differences in cultivars at different growth stages, seed and stover at harvest were not significant for N uptake (Table 2) but significant for S uptake (Table 3). Among canola cultivars, OCN 3 registered higher N uptake than GSC 5 at 110 DAS and in seed whereas it registered significantly higher S uptake at 110 DAS, seed and stover than GSC 5.

Application of N alone ($N_{50+50}S_0$) resulted in significantly higher N content at all growth stages as well as in seed and stover at harvest as compared to without application of nutrients and application of S only. Application of S along with N in two equal splits ($N5_{0+50}S_{20+20}$) at sowing and vegetative stage further increased the N content which was significantly higher than application of N alone at all growth stages. Application of N and S in three splits failed to increase N content in plant compared to N applied atone in two equal splits. Nitrogen uptake by plants at 50, 80 and 110 DAS and in seed arid stover at harvest with split application of both N and S ($N_{50+50}S_{20+20}$) was higher than that registered with application of N or S alone ($N_{50+50}S_0$, N_0S_{40}), application of N in two splits along with basal application of S ($N_{50+50}S_{40}$) and without application of nutrients (N_0S_0). The highest N uptake at all growth stages (except 50 DAS), seed and stover at harvest was registered with split application of N and S ($N_{50+50}S_{20+20}$).

Sulphur applied alone @ 40 kg/ha at sowing resulted in significantly higher S content in comparison to all other treatments (Table 3). Both N and S applied in two equal splits registered higher S content at all growth stages than their application in 3 splits. Basal application of 40 kg S/ha along with 100 kg N/ha applied half at sowing and half at vegetative stage resulted in higher S content than application of N alone. Similarly, split application of N and S ($N_{50+50}S_{20+20}$) resulted in significantly higher S uptake at all growth stages, seed and stover than the application of same quantity of N in two equal splits and S only at sowing. Application of N and S in three splits as $N_{50+25+25}S_{20+10+10}$, $N_{25+50+25}S1_{0+20+10}$, $N_{34+33+33}S1_{4+13+13}$ registered almost similar S uptake at all growth stages. Application of 40 kg S/ha at sowing though resulted in significantly higher S uptake than without application of nutrients but registered lower uptake than that observed with application of N alone at all growth stages, seed and stover. Increases in N content and uptake and S content and uptake by rapeseed-mustard with varying doses of N and S have been reported by several workers (Dubey *et al.*, 1994, Aulakh *et al.*, 1995, Rana and Rana 2003, Ghadge *et al.*, 2005, Sah *et al.*, 2006).Combined application of 150 kg N + 60 kg S/ha significantly improved uptake of N and S (Aulakh *et al.*, 1980) indicating positive N x S interaction.

The study reveals difference in genotypes for enzyme activity which was further influenced by application time of N and S. Though N and S content and N uptake did not vary much in different genotypes, differences were observed for S uptake. Time of application of nutrients also influenced the N and S content and uptake. Split application of N and S ($N_{50+50}S_{20+20}$) resulted in significantly higher N and S uptake at all growth stages, seed and stover than other treatments.

Table 2. Influence of cultivars and application of nitrogen and sulphur on nitrogen content and uptake of oilseed rape

Treatment	Nitrogen					Nitrogen					
	50	80	110	Maturity			50	80	110		Maturity
	DAS	DAS	DAS	Seed	Stover	DAS	DAS	DAS	Seed	Stover	Total
Cultivars											
OCN 3	2.55	2.37	2.16	3.2	0.64	30.7	59.0	91.3	58.7	27.5	86.2
GSC 5	2.66	2.48	2.27	3.4	0.73	34.1	59.9	87.7	54.4	28.3	82.7
GSL 1	2.55	2.37	2.16	3.2	0.66	39.1	71.0	107.3	51.1	34.4	85.5
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Application of nutrients (kg/ha)											
N_0S_0	2.39	2.21	2.00	3.0	0.46	10.2	29.9	51.10	31.4	11.1	42.5
N_0S_{40}	2.29	2.11	1.90	3.0	0.39	10.4	32.4	54.6	34.0	10.1	44.1
$N_{50+50}S_0$	2.65	2.47	2.26	3.3	0.75	39.0	69.6	104.8	60.3	34.7	95.0
$N_{50+50}S_{40}$	2.53	2.35	2.14	3.1	0.63	37.4	68.7	101.6	60.1	29.4	89.5
$N_{50+25}S_{+20+20}$	2.85	2.67	2.46	3.5	0.93	43.5	79.2	118.1	65.3	44.7	110.0
$N_{50+25+25}S_{20+10+10}$	2.66	2.48	2.27	3.4	0.76	44.8	75.0	110.5	61.7	37.3	99.0
$N_{34+33+33}S_{14+13+13}$	2.67	2.49	2.28	3.3	0.74	43.4	77.1	112.7	62.2	37.2	99.4
$N_{25+50+25}S_{10+20=10}$	2.65	2.47	2.26	3.3	0.74	48.3	74.6	109.9	62.8	36.2	99.0
CD at 5%	0.16	0.16	0.16	0.16	0.09	7.2	12.4	13.1	4.9	5.0	

Table 3. Influence of cultivars and application of nitrogen and sulphur on sulphur content and uptake of oilseed rape

Treatment	Nitrogen					Nitrogen					
	50 DAS	80 DAS	110 DAS	Maturity Seed	Maturity Stover	DAS	50 DAS	80 DAS	110 Seed	Maturity Stover	Total
Cultivars											
OCN 3	0.39	0.35	0.32	0.18	0.47	4.5	8.7	13.1	8.5	7.3	15.8
GSC 5	0.38	0.34	0.31	0.17	0.46	4.7	8.2	11.8	7.5	6.5	14.0
GSL 1	0.39	0.35	0.31	0.18	0.47	5.7	10.1	15.2	7.3	8.8	16.1
CD (p = 0.05)	NS	NS	NS	NS	NS	0.9	0.9	0.7	0.6	0.8	
Application of nutrients (kg/ha)											
N_0S_0	0.38	0.34	0.30	0.17	0.46	1.6	4.6	7.8	4.7	4.2	8.9
N_0S_{40}	0.43	0.39	0.35	0.22	0.51	1.9	6.0	10.2	5.9	5.7	11.6
$N_{50+50}S_0$	0.35	0.31	0.27	0.14	0.43	5.1	8.8	12.9	7.8	6.7	14.5
$N_{50+50}S_{40}$	0.37	0.33	0.30	0.16	0.45	5.5	9.8	14.3	8.5	8.0	16.5
$N_{50+50}S_{20+20}$	0.40	0.36	0.33	0.19	0.48	6.2	10.8	15.8	9.0	9.3	18.3
$N_{50+25+25}S_{20+10+10}$	0.39	0.35	0.31	0.18	0.47	6.5	10.6	15.4	8.7	8.8	17.5
$N_{34+33+33}S_{14+13+13}$	0.38	0.34	0.30	0.17	0.46	6.1	10.6	15.2	8.6	8.6	17.2
$N_{25+50+25}S_{10+20+10}$	0.39	0.35	0.31	0.18	0.47	7.0	10.5	15.2	8.9	8.6	17.5
CD (p = 0.05)	0.01	0.01	0.01	0.01	0.01	0.9	1.7	1.7	0.6	1.1	

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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON YIELD, QUALITY AND NUTRIENT UPTAKE OF *ISABGOL* (*PLANTAGO OVATA*)

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ABSTRACT

A field experiment comprising six levels of fertilizers/manures and three biofertilizers was conducted in randomized block design and replicated three at Agronomy farm, S.K.N. College of Agriculture, Jobner (Rajasthan) during rabi, 2005-06 on loamy sand soil. Results showed that application of vermicompost @ 1 .5 t/ha + 50% RDF significantly increased seed and straw yields and total NPK uptake over control, RDF, FYM @ 8.0 t/ha, vermicompost @ 3.0 t/ha ana FYM @ 4.0 t / ha + 50% RDF. Protein content and swelling capacity were also significantly increased with application of fertilizers/manures except FYM @ 8.0 t/ha and maximum was recorded under vermicompost @ 1.5 t/ha + 50% RDF. Organic carbon and available NPK in soil at harvest of the crop were significantly higher with application of fertilizers/manures. Results further revealed that seed and straw yields, total NPK uptake and available N content in soil at harvest were significantly higher with inoculation due to *Azotobacter* as well as *Azospirillum* over control.

Key words : Isabgol, yield, quality, nutrient uptake, vermicompost, biofertilizers.

In India, isabgol has acquired the name "Dollar earner" in North Gujarat and South Western Rajasthan. As a whole, India commands a near monopoly in production and export of the seed and husk in the world market and about 80-90 per cent produce is exported through which about Rs.160 crores is earned annually. There is a lack of proper nutrient management in isabgol as the productivity of isabgol in Rajasthan is low (680 kg/ha). Nitrogen and phosphorus are the major primary nutrients required by the crop. The research findings also indicated that a judicious combination of organic and inorganic fertilizers will maintain soil fertility and sustain higher level of productivity. Farm yard manure/vermicompost is rich in organic matter and can be supplemented with NPK fertilizers. Although it is costlier than chemical fertilizers on nutrient basis but other beneficial effect on soil can compensate for the added cost. FYM/vermicompost not only provides a variety of plant nutrients but also improves the physico-chemical and biological properties of soil. Besides improving the fertilizer use efficiency and soil health, low nitrogen losses due to slow release of nutrients from the organic manure is an added advantage. For sustainable crop production, conjunctive use of organic, inorganic and biofertilizers is very much essential. Biofertilizers alongwith organic manure play an important role in sustainable agriculture. A number of micro-organisms including nitrogen fixing bacteria i.e. *Azotobacter* and *Azospirillum* have been used as biofertilizers to increase availability of nitrogen. Though some information on isabgol nutrition is available the integrated nutrient management on this particular crop is still to be worked out. Keeping these in view, the present investigation entitled "effect of integrated nutrient management on growth and yield of isabgol (*Plantago ovata*) was undertaken.

MATERIALS AND METHODS

A field experiment was conducted at Agronomy Farm, S.K.N. College of Agriculture, Jobner, in *rabi* 2005-06. The soil of experimental field was alkaline in reaction (pH 8.5), poor in available nitrogen (110 kg/ha) and phosphorus (20.54 kg P_2O_5/ha) and medium in potassium (175.05 kg/ha). The experiment consisting 18 treatment combinations of six level of fertilizer/ manure (F$_1$: control, F$_2$: RDF (40 kg N + 30 kg P$_2$O$_5$/ha); F$_3$: (FYM @ 8 t/ha F$_4$: vermicompost @ 2 t/ha); F$_5$: FYM @ 4 t /ha + 50% RDF; F$_6$ vermicompost @ 1 .5 t/ha + 50% RDF) and three levels of biofertilizers (B$_0$: control; B$_{AZt}$: *Azotobacter* B$_{Azs}$: *Azospirillum*) was laid out in a randomized block design with three replications.

RESULTS AND DISCUSSION

Application of vermicompost @ 1.5 t/ha + 50% RDF recorded significantly highest seed and straw yield and total NPK over control, RDF, FYM @ 8.0 t/ha, vermicompost @ 3.0 t/ha^1 and FYM @ 4.0 t/ha + 50% RDF. The higher seed yield of isabgol seemed to be the cumulative effect of yield attributes such as spikes per plant and seeds 1 spike were significantly enhanced due to application of vermicompost @ 1.5 t/ha + 50% RDF. The present trend of increase in yield is in close conformity with the findings of Muniratnanum *et al.* (2004). Since uptake of nutrients is a function of their concentration and yield, the higher yield of seed and straw along with higher concentration of NPK might have be resulted in higher uptake of these nutrients. Similar findings were also reported by Dadheech *et al.* (2004). Data(Table 1) revealed that application of vermicompost @ 1.5 t/ha + 50% RDF significantly increased the protein concentration over control, FYM @ 8.0 t/ha and vermicompost @ 3.0 t/ha but remained at par to RDF and FYM @ 4.0 t ha^{-1} + 50% RDF. Further examination of data indicated that vermicompost @ 1.5 t /ha + 50% RDF showed highest swelling capacity and significantly superior to control and FYM @ 8.0 t /ha. However, fertilizers / manures did not cause significant difference in husk recovery. Similar results were also reported by Dadheech *et al.* (2004).

Application of fertilizers/manures significantly improved organic carbon and available NPK in soil over control (Table 1). The highest values were obtained with FYM @ 8.0 t ha^{-1} followed by vermicompost @ 3.0 t/ha for organic carbon and available N and vermicompost @ 1.5 t /ha + 50% RDF for available NPK. This is because of FYM and vermicompost bind soil particles into aggregates and have which a profound effect on the improvement of soil structure. Organic matter has solubilizing effect on some mineral compounds present in the soil and bring about the conversion of a number of chemical elements into available forms to plants. Similar results were also advocated by Singh *et al.* (1994).

Table 1. Effect of integrated nutrient management on yield and quality of isabgol and organic carbon, available N, P and K in soil after harvest

Treatments	Seed yield (q/ha)	Straw yield (q/ha)	Nutrient uptake (kg/ha)			Quality parameters.			Soil health			
			N uptake	P uptake	K uptake	Protein content (%)	Husk recovery (%)	Swelling capacity (ccg^{-1})	Organic carbon	Available nitrogen (kg/ha)	Available phosphorus (kg/ ha)	Available potassium (kg/ ha)
Fertilizers/manures												
Control	9.01	21.12	33.66	13.16	23.85	11.31	31.22	11.20	0.181	120.90	18.60	155.40
RDF (40 kg N + 30 kg P$_2$O$_5$/ha)	12.89	28.58	50.18	19.16	33.47	12.25	32.25	11.80	0.197	125.90	21.30	180.00
FYM @ 8.0 t/ha)	10.72	24.71	41.07	15.84	28.24	11.68	31.75	11.40	0.287	136.10	22.40	185.10
Vermicompost @ 3.0 t/ha)	12.29	28.16	47.65	18.40	32.46	11.87	32.05	11.50	0.240	134.70	20.20	175.80
FYM @ 4.0 t/ha) + 50 % RDF	12.56	28.29	48.94	18.72	32.88	12.13	32.12	11.60	0.215	128.60	22.10	181.30
Vermicompost @ 1.5 t/ha)+ 50% RDF	14.51	31.68	56.90	21.57	37.51	12.44	32.40	11.90	0.237	130.40	22.20	182.70
SEm±	0.51	1.03	1.39	0.60	0.90	0.14	0.48	0.18	0.010	2.44	0.52	4.20
CD at 5%	1.45	2.94	4.00	1.73	2.58	0.40	NS	0.51	0.035	6.99	1.49	12.08
Biofertilizers												
Control	11.16	25.56	42.89	16.51	29.34	11.81	31.69	11.45	0.219	126.3	20.76	173.46
Azotobacter	12.57	28.04	48.68	18.59	32.65	12.06	32.20	11.68	0.232	131.9	21.43	179.53
Azospirillum	12.26	27.67	47.47	18.10	32.06	12.00	32.00	11.57	0.227	131.1	21.21	177.16
SEm±	0.36	0.71	0.98	0.43	0.64	0.10	0.34	0.13	0.01	1.62	0.39	2.97
CD at 5%	1.04	2.08	2.83	1.22	1.83	NS	NS	NS	NS	4.75	NS	NS

The data (Table 1) further indicated that inoculation with *Azotobacter* and *Azospirillum* significantly increased the seed and straw yields, total NPK uptake and available nitrogen over no inoculation, but both were rat par. However, inoculation with *Azotobacter* and *Azospirillum* did not cause significant difference in quality parameters, organic carbon, available P and K uptake over control. Significant increase in seed and straw yields by inoculation with *Azotobactor* and *Azospirillum* might be due to the fact that *Azotobactor* are known to produce antibiotic substances and also produces IAA and gibberellins or gibberellins like substances, resulting in vigorous plant growth and dry matter production which in turn resulted in better fertilization, grain development and yield attributes and ultimately the seed and straw yields. Similar results were also reported by Muniratham *et al.* (2004). The uptake of NPK might have enhanced due to increased content and yield of seed and straw with the use of biofertitizers. The available soil nitrogen increase with biofertilizers may be due to better utilization of native nitrogen with increase in nitrogen fixation. Similar results were also reported by Singh and Singh (2004).

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EFFECT OF BORON AND PHOSPHORUS APPLICATION ON YIELD AND UPTAKE OF NUTRIENTS IN LENTIL

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ABSTRACT

A field experiment was conducted during 2006-08 at Bichpuri (Agra) to study the effect of B and P levels on the yield and nutrients uptake in lentil. The grain and straw yield of lentil increased significantly up to 4 kg B and 90 kg P_2O_5 /ha. The highest grain and straw yield (13.58 and 15.0 q/ha) at 4 kg B/ha was 12.6 and 20.0% higher in comparison to the yield at control. Similarly 90 kg P_2O_5 /ha produced highest grain and straw yield (15.47 and 18.18 g/ha), which was 46.8 and 45.0% higher compared to control. Thus, application of phosphorus gave higher yield than of boron. Application of B and P increased significantly the uptake of N, P and B in grain and straw over control. Protein content and yield of lentil grain also increased significantly with B and P application.

Key words : Boron, phosphorus, yield, uptake, nutrients, lentil.

Lentil (*Lens culinaris*) is one of the important pulse crops grown in India. It is preferred by the farmers of rainfed and dry land areas because of its capability to yield satisfactorily under sub optimal level of resources. Inherited yield potentials of the crop, however can be realized by providing plant nutrients in balanced amount along with suitable agronomic package to crop. Besides, nitrogen, phosphorus also limits the productivity of this crop. Phosphorus stimulates seed setting hastens maturity and enhanced protein content. It plays an important role in the nutrition of legumes and improves biological nitrogen fixation and quality of grains. Boron is an essential micronutrient needed by plants but its higher amounts could be toxic and harmful to crops. It plays an important role in cell differentiation and development, translocation of photosynthates and growth regulators from sources to sink. Judicious combination of P and B may bring considerable yield increase owing to their complementary effects. The present investigation was, therefore, carried out to find out optimum requirement of P and B for lentil in alluvial soil of Agra.

MATERIALS AND METHODS

A field experiment was conducted with lentil (Var. Pant L-406) at Raja Balwant Singh College, Research Farm, Bichpuri (Agra) during *rabi* seasons of 2006-07 and 2007-08 in a sandy loam soil. The soil was alkaline in reaction (pH: 7.9), free from salinity (0.20 dSm^{-1}), deficient in HWS-B (0.41 mg/kg) and low in available P (8.9 kg/ha). Treatments comprised of four levels of each of B (0, 1, 2 and 4 kg/ha) as borax and phosphorus (0, 30, 60 and 90 P_2O_5 /ha) as triple superphosphate applied at the time of sowing. A total of 16 treatment combinations were replicated thrice in randomized block design. Lentil was sown on November 20, both the years. A basal application of 20 kg N and 60 kg K_2O/ha through urea and muriate of potash, respectively was applied at sowing. The crop was harvested at maturity and grain and straw yield was recorded. Nitrogen content in grain and straw were determined by Kjeldahl method. The grain and straw samples were digested in di acid (HNO_3: $HClO_4$) mixture. Phosphorus and boron in the acid extract were determined by molybdate vanadate yellow colour method (Jackson, 1973) and carmine method (Hatcher and Wilcox 1950), respectively.

Results and Discussion

Both the elements exerted positive and significant influence on the grain and straw yield of lentil (Table 1). Increasing levels of applied boron increased the grain yield of lentil but the increase in yield was significant only up to 2 kg B/ha in both the years. But increases in straw yield were significant up to 4 kg B/ha. The increases in grain yield due to 1, 2 and 4 kg B/ha over control were 5.1 and 5.8, 8.7 and 9.3 and 12.0 and 13.3 percent, respectively during 2006-07 and 2007-08. The corresponding increases in straw yield were 11.1 and 11.8, 14.9 and 14.4 and 20.7 and 19.2 percent. The marked response in grain and straw yield due to B addition may be attributed to the deficiency of available B in the soil. The non-significant increase in yield of grain due to higher level of B may be attributed to the increased accumulation of B in the root medium with its addition to soil beyond tolerance limit to the lentil crop. Similar observations were also reported in lentil crop by Singh and Singh (1983).

Application of 90 kg P_2O_5/ha produced significantly higher grain and straw in comparison to control in both the years. The higher grain and straw yields (15.53 and 15.4 and 18.17 and 18.20 q/ha) were recorded with 90 kg P_2O_5/ha, which was 46.8 and 46.8 and 44.3 and 45.7 percent higher than control. Phosphorus helps in formation of more nodules, vigorous root development and better N_2 fixation and overall better development of plants. In addition, the soil of the experimental field was poor in P content and its application improved the nutrient availability status, resulting into greater uptake, which might have increased the photosynthates. During later stages, the more assimilates are diverted to storage compounds resulting in to increased grain yield. Similar results were also reported by Kumar and Kushwah (2006).

Protein content increased significantly with the application of boron, being lowest at control (24.56 and 23.87%) and highest at 4 kg B/ha (25.12 and 24.50%). Application of phosphorus up to 90 kg P_2O_5/ha tended to increase the protein content in grain over control in both the years. This increase in protein content might be attributed to increase in the activity of enzymes involved in protein synthesis on its addition. This led to increase in protein content with the application of phosphorus. The protein yield increased significantly up to the level of 4 kg B/ha and 90 kg P_2O_5/ha over control. This increase in protein yield may be attributed to higher production of grain and improvement in protein percentage with B and P addition.

The uptake of nitrogen by grain and straw increased significantly over control by the application of boron and phosphorus (Table 2). Increase in N uptake was significant due to

Table 1. Effect of boron and phosphorus levels on grain and straw yield, content and yield of protin in lentil grain

Treatment	Grain yield (q/ha)		Straw yield (q/ha)		Protein content (%)		Protein yield	
	2006-07	2006-07	2006-07	2006-07	2006-07	2006-07	2006-07	2006-07
Boron (kg/ha)								
0	12.13	11.98	13.76	13.78	24.56	23.87	2.98	3.86
1	12.75	12.67	15.29	15.41	24.75	24.12	3.15	3.06
2	13.19	13.10	15.81	15.76	24.87	24.25	3.28	3.18
4.	13.59	13.57	16.61	16.43	25.12	24.50	3.41	3.32
CD at 5%	0.88	0.79	1.43	1.53	0.06	0.07	0.024	0.026
Phosphorus								
0	1058	10.50	12.59	12.49	24.25	23.62	2.56	2.48
30	11.86	11.80	14.17	14.11	24.62	23.94	2.92	2.82
60	13.69	13.61	16.54	16.59	24.94	24.31	3.41	3.31
90	15.53	15.41	18.17	18.20	25.44	24.81	3.95	3.82
CD at 5%	0.88	0.79	1.43	1.53	0.06	0.07	0.024	0.026

applied boron up to 2 kg B ha^{-1} by grain and straw of lentil. The increases in an uptake by grain and straw due to 1, 2 and 4 kg B ha^{-1} over control were 6.8 and 12.8, 11.7 and 17.5 and 13.4 and 24.2 percent, respectively. Phosphorus application increased significantly the uptake of nitrogen by grain and straw. The higher yields of lentil grain and straw with P addition absorbed larger quantities of N from the soil thus depleting the soil of more nitrogen consequently showing its higher uptake in plants. Similar results were reported by Nehara *et al.* (2006). There was an obvious increase in P uptake by the crop as a result of B addition up to 4 kg ha^{-1}. Highest mean P uptake by grain and straw (4.5 and 2.9 kg/ha was due to 4 kg B/ha and the lowest mean uptake (3.7 and 2.1 kg/ha) due to no boron addition to the crop. Application of 90 kg P_2O_5/ha recorded the highest P uptake (5.6 and 3.7 kg/ha) in grain and straw followed by 60, 30 and 0 kg P_2O_5/ha (control) level. Cumulative effect of increase in P content and grain and straw yield might have led to significant increase in P uptake by the crop. Kumar and Kushwaha (2006) also reported similar results. The boron uptake increased up to application of 4 kg B/ha and 90 kg P_2O_5/ha by grain and straw. This may be attributed to increase in their availability in soil and increased grain and straw production as a result of B and P addition. These results are in agreement with the findings of Kumar *et al.* (2006) in respect of B uptake by grain and straw of gram.

Table 2. Effect of boron and phosphorus levels on uptake of nutrients in lentil grain and straw (mean of two years)

Treatment	Nitrogen (kg/ha)		Phosphorus (kg/ha)		Boron (g/ha)	
	Grain	Straw	Grain	Straw	Grain	Straw
Boron (kg/ha)						
0	46.9	19.4	3.7	2.1	25.0	42.7
1	50.1	21.9	4.0	2.4	33.5	56.4
2	53.2	24.1	4.5	2.9	49.2	84.4
4	2.28	1.25	0.09	0.07	5.0	8.0
CD at 5%	4.65	2.56	0.20	0.15	10.1	16.6
Phosphorus						
0	40.4	17.8	2.9	1.5	29.4	50.4
30	46.2	20.0	3.7	2.1	34.4	58.2
60	53.0	23.9	4.5	2.9	38.4	68.8
90	62.5	26.7	5.6	3.7	45.0	76.4
CD at 5%	4.65	2.56	0.20	0.15	10.1	16.6

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PHYSIOLOGICAL STUDIES ON PERFORMANCE OF BT AND NON-BT COTTON (*GOSSYPIUM HIRSUTUM*) HYBRIDS UNDER DIFFERENT LEVELS OF NITROGEN FERTILIZATION

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ABSTRACT

A two kharif season field experiment (2007 & 08) was made to study the physiological basis of Bt cotton hybrids superiority under different levels (kg/ha) of nitrogen fertilization (0, 60,120,180) over non-Bt hybrid. Bt cotton hybrids (RCH 317 & RCH 134) with higher crop growth rate during shorter reproductive phase coupled with higher boll retention rate (72.9%) owing to presence of *Cry1Ac* gene resulted in 47.4% higher seed cotton yields than non-Bt hybrid LHH 144. Each successive increase of 60 kg N up to 180 kg/ha significantly increased leaf area, biomass production, crop growth rate, boll number and boll weight ultimately resulting in markedly higher seed cotton yields.

Key words : Bt cotton, nitrogen, seed cotton yield.

The dependence of over 15 million farmers spread over 10 states on cotton cultivation (Sharma, 1998) and the crop supplying raw material to textile and oil industry shows the importance of cotton as a commercial crop and is truly called a white gold. The bollworms menace in cotton and their unsuccessful and costly control through pesticides made its cultivation uneconomical. The development of Bt (*Bacillus thuringiensis*) cottons with inherent ability to resist bollworm attack and their cultivation in India since 2002 has reversed the above trend. The success of Bt cottons can be judged from the fact that they accounted for over 66% of total cotton acreage (9.53 m ha) in 2007-08. Nitrogen is considered as the most important nutrient for maximizing the cotton yield (Breitenbeck and Boquet, 1993) and its deficiencies influence leaf coloring as well as physiological efficiency of cotton (Maples *et al.*, 1988). A deficiency of N in cotton generally results in lower plant biomass production and premature senescence, as evidenced by yellowing or chlorosis of older leaves. A reduced fruiting index (Boquet and Breitenbeck, 2000) were also reported under nitrogen deficiency. The information on Bt cotton hybrids with respect to nitrogen is meager. The introduction of Bt hybrids in cotton no doubt has increased the productivity over non-Bt hybrids due to boll worm resistance. There is need to understand the physiology of Bt cottons in relation to nitrogen nutrition. Keeping this in view, the present experiment was conducted.

MATERIALS AND METHODS

Field experiments were conducted during June-December 2007 and 2008 at J.V. College, Baraut, Uttar Pradesh on a sandy loam soil (67% sand, 14% silt and 19% clay) with pH 7.8 (1:2.5 soil to water ratio) containing 0.40% organic carbon, 198 kg/ha Kjeldahl N, 13.7 kg/ha 0.5 M $NaHCO_3$ extractable P, 177 kg/ha NH_4OAC extractable K, The moisture content of soil (0-90 cm) at field capacity and permanent wilting point were 17.5 and 7.5% respectively, with a bulk density of 1.50 Mg/m^3.

The experiment with 12 treatments comprising combination of 3 cotton hybrids ('RCH 134 Bt', 'RCH 317 Bt' and 'LHH-144' non-Bt) in main plots and 4 nitrogen levels (0, 60, 120 and 180 kg/ha) in sub plots was conducted in split plot design with four replications. Cotton was sown on 1 June during both the years at 90 cm x 60 cm by dibbling one seed /hill on a well prepared land. after a pre-sowing irrigation. Gap filling was done on 10th day after sowing (DAS) to ensure 100% population. The crop received a basal dose of 26.4 kg P/ha and 42 kg K/ha as single super phosphate and muriate of potash respectively. Nitrogen as per treatment through prilled urea was applied in 3 splits (50% at sowing, 25% each at 30 and 60 days after sowing). The crop was grown under recommended package of practices under irrigation. Biomass and leaf area were recorded at 30 days interval starting from 60 DAS till the final harvest from a single plant cut to ground level in each observation. Boll growth was recorded from first formed (five) tagged bolls of three plants. Leaf area, weight and N concentration of fully opened recent three leaves were measured and averaged. The mean data was subjected to statistical analysis by adopted standard procedures described by Cochran and Cox (1957). For the characters with similar trend during both the years, pooled data was presented.

RESULTS AND DISCUSSION

Growth analysis

Both the Bt cotton hybrids had statistically similar plant height that inturn was significantly lower than that of non Bt hybrid LHH 144 (Table 1). The variation in plant height among three cotton hybrids was ascribed to their genotypic nature. Similar differences in plant height among Bt and non-Bt hybrids were reported by Halemani *et al.* (2004). Each successive increase of 60 kg N up to 120 kg/ha significantly increased cotton plant height. The results are in close agreement with the findings of McConnell *et al.* (2008).

The leaf area (LA) of cotton plant (m^2, mean of two seasons) in general, increased from 0.139 at 30 DAS to the highest of 1.401 at 90 DAS and decreased there after. Among cotton hybrids, non-Bt hybrid LHH 144 and among N levels 180 kg/ha recorded the highest LA/plant. Non-Bt hybrid LHH 144 maintained it's LA even at 150 DAS, while RCH 317 and RCH 134 started decreasing LA after 90 and 120 DAS respectively. The long duration of LHH 144 (206 days to maturity) cotton led to its maintaining higher LA even at 150 DAS. The decline in LA of RCH 317 and RCH 134 was ascribed to their short life cycle (158 and 177 days respectively). Similar differences in LA among genotypes (Singh *et al.*, 2008) and with increase in N fertilization (Das *et al.*, 2006) were reported.

Table 1. Plant height, monopod, and biomass production and its partitioning of cotton hybrids at maturity as affected by nitrogen fertilization

Treatment	Plant height (cm)	Monopods/ plant	Biomass partitioning (g) Leaves	Stem	Reproductive parts	Total biomass production (g/plant)
Cotton hybrids						
RCH 134 (Bt)	101.7	2.34	33.0	171.0	232.5	436.5
RCH 317 (Bt)	103.3	2.43	32.1	171.0	234.0	437.1
LHH 144 (non-Bt)	117.4	2.98	72.9	216.8	170.5	460.1
SEm ±	2.06	0.084	5.0	3.9	4.2	4.7
CD (P=0.05)	7.15	0.291	17.3	13.5	14.6	16.2
Nitrogen dose (kg/ha)						
0	98.4	2.15	30.2	145.0	156.0	331.2
60	104.4	2.50	45.6	187.0	212.9	445.5
120	111.6	2.78	50.7	201.5	232.0	484.2
180	115.4	2.89	57.2	211.5	248.5	517.2
SEm ±	1.62	0.061	3.9	3.0	3.3	3.7
CD (P=0.05)	4.72	0.178	11.4	8.9	9.7	10.7

The mean biomass production (g/plant) was highest in non-Bt hybrid LHH 144 up to 90 DAS. There after Bt hybrids surpassed non Bt hybrid in biomass production up to 150 DAS. RCH 317 did not record any further increase in biomass after 150 DAs, however, RCH 134 and LHH 144 continued to increase their biomass and finally LHH 144 produced the highest biomass at maturity among the cotton hybrids. The higher biomass production of Bt hybrids at 90-150 DAS and LHH 144 at (150-harvest) was ascribed to the fact that this period coincided with peak boll formation. Similar reports of higher biomass production of LHH 144 over MECH 162 Bt hybrid were reported by Nehra *et al.* (2004).

Each successive increase of 60 kg N up to 180 kg/ha significantly increased cotton crops biomass production from sowing to the harvest of the plants. N being component of chlorophyll aided in leaf retention for longer period and thus its biomass were higher with greater N application. Bharadwaj and Singh (1988) reporting increased dry matter production in cotton found that 90% of increase in biomass could be ascribed to increase in leaf area. The results are in close agreement with the findings of Das *et al.* (2006) who also obtained increased biomass production with increase in N fertilization.

The partitioning of biomass at harvest among different components indicates that reproductive structures mass is markedly greater in Bt hybrids than non-Bt hybrid. Non Bt hybrid has greater proportion of leaf and stem mass than Bt hybrids. Each successive increase of 60 kg N up to 180 kg/ha significantly increased stem and reproductive parts production at harvest. However, the leaf mass failed to increase markedly with application of N over 120 kg/ha (Table 1).

The mean crop growth rate (CGR) of cotton plant (g/m^2/day) as affected by cotton hybrids and nitrogen fertilization were presented in Fig. 2. In general, CGR of cotton increased from the lowest of 2.41 at 30-60 DAS to the highest values (13.77) at 90-120 DAS and decreased there after. Among cotton hybrids, non-Bt hybrid LHH 144 recorded higher CGR values at 30-60 and 60-90 DAS; however, two Bt hybrids at 90-120 DAS overtook LHH 144. Further at 120-150 DAS, RCH 317 had higher CGR values than LHH 144 and RCH 134 also. The greater increase biomass in shorter period has resulted in high CGR values. The results of this study are in close agreement with those Goody *et al.* (1998) who reported higher CGR values of Bt hybrids during 84-105 DAS. Among N levels, control (0 kg/ha) and 180 kg/ha recorded the lowest and highest CGR values from 30-60 to 120-150DAS.

Reproductive growth analysis

The perusal of two years mean data (Table 2) indicates that LHH 144 has produced significantly higher sympodia/plant than the two Bt hybrids that were at par with each other. Similar higher number of sympodia production in non-Bt hybrid was reported by Srinivasan (2006). The Bt cotton hybrid RCH 317 was quick to enter reproductive phase as evident from appearance of first flower (75 days) first boll (80 days) and time taken fifty % flowering (78.5 days). The reproductive duration (first flower appearance to maturity) was also the lowest (83.5 days) in this hybrid. Non Bt hybrid LHH 144 was late to first flowering (90.5 days) and took longest time for completion of reproductive phase (115.5 days). The other Bt hybrid RCH 314 remained in between the RCH 317 and LHH 144. Similar cultivar difference in days to flowering and maturity among Bt hybrids was reported by Buttar *et al.* (2007).

Each successive increase of 60 kg nitrogen/ha up to 120 kg has significantly increased the sympodia produced /plant, the days taken to first flowering and to maturity. Further increase in N dose has no marked effect. A similar increase in sympodia production (Toaima, 2007) and delayed maturity of the cotton crop (McConnell *et al.*, 2008) with increase in N dose were reported.

Yield attributes and yield

Maximum number of flowers was produced by non Bt hybrid LHH 144 and the minimum by RCH 134. Of these produced flowers, LHH 144 was less efficient in converting them into

Table 2. Reproductive characters, yield attributes and yields of cotton hybrids as affected by nitrogen fertilization

Treatment	Days to first flower	Days to first boll	Days to 50% flowering	Days to maturity	Sympodia/ plant	Retained Flowers	No.of Bolls	Boll weight (g)	Seed cotton yield (g/ plant)
Varieties									
RCH 134 (Bt)	82.0	87.0	85.5	174.0	22.25	76.6	55.6	4.09	107.21
RCH 317 (Bt)	75.0	80.0	78.5	158.5	25.75	83.6	61.2	3.67	108.10
LHH 144 (non-Bt)	90.5	95.0	94.0	206.0	31.50	92.0	39.1	4.15	73.06
SEm ±	1.39	1.75	2.00	1.94	1.290	2.72	2.23	0.089	2.200
CD (P=0.05)	4.81	6.06	7.63	6.71	4.463	9.41	7.72	0.308	7.612
Nitrogen level (kg/ha)									
0	73.9	79.2	77.5	164.0	19.33	68.0	39.5	3.81	76.64
60	82.7	87.7	86.7	177.0	25.50	82.1	49.9	3.95	94.14
120	85.9	90.2	89.2	186.0	29.33	89.8	56.7	4.00	105.14
180	87.7	92.4	91.2	190.4	31.83	96.2	61.5	4.06	110.32
SEm ±	1.02	1.28	1.73	1.42	0.942	1.99	1.63	0.065	1.606
CD (P=0.05)	2.95	3.72	5.03	4.12	2.740	5.78	4.74	0.189	4.673

harvestable bolls as evident from the fact that only 42.5% of the retained flowers became bolls. Both Bt hybrids being similar and on an average converted 72.9% of retained flowers into harvestable bolls. The lower retention of reproductive structures in LHH 144 (non-Bt) was ascribed to boll worm damage that was effectively taken care by resistance induced cotton through *Cry 1Ac* gene in Bt hybrids. The results are in close agreement with the findings of Hebbar *et al.* (2007). The boll weights of RCH 134 and LHH 144 were found at par and together have significantly higher boll weight than RCH 317. Thus the higher boll number of RCH 317 was offset by higher boll weight of RCH 134 and thus these two Bt hybrids finally produced similar seed cotton yields (SCY). Based on two years mean, Bt hybrids have 47.4% higher SCY/ plant than non-Bt hybrid. Kumar *et al.* (2007) from Karnataka, also recorded significantly higher seed cotton yield in Bt (RCH-2 Bt) than non-Bt cotton hybrid (NHH-44).

Each successive increase of 60 kg nitrogen/ ha up to 180 kg and 120 kg/ha has significantly increased flowers and bolls/plant respectively. However, the boll weight of N fertilized treatments was at par irrespective of its dose. The boll weight increase over control was significant with 120 kg N application only. The cumulative effect of higher boll number and boll weight resulted in significant increase in seed cotton yield /plant up to 180 kg N/ha fertilization. Significant increases seed cotton yield with increased N fertilization was reported by Toaima (2007) and Singh *et al.* (2008).

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INFLUENCE OF BIOFERTILIZERS, FERTILITY LEVELS AND WEED MANAGEMENT PRACTICES ON CHICKPEA (*CICER ARIETINUM* L.) UNDER LATE SOWN CONDITION

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ABSTRACT

A field experiment was conducted for two consecutive years from 2003-04 during winter season at the Varanasi to find out an effective biofertilizer, fertility level and weed management practice on weed growth and yield of chickpea under late sown condition. Application of VAM exhibited significantly higher weed dry matter accumulation than the application of other bio-fertilizer sources. However, maximum seed and straw yields were recorded with the combined application of *Rhizobium* and VAM which was on par with inoculation of *Rhizobium* but significantly higher than the VAM alone in both the years. Application of 75% recommended NPK dose recorded the lowest weed dry weight than rest of the fertilizer levels. The highest chickpea seed I6. and 17.2 q/ha) and straw yields (36.2 and 37.3 q/ha) was noted under 125% recommended NPK dose. Pre-emergence application of pendimethalin 0.5 kg/ha coupled with one hoeing at 40 days after sowing significantly reduced the weed dry weight which resulted in 16.5 per cent and 15.3 per cent in 2002-03 and 2003-04, respectively higher seed yield over unweeded check condition.

Key words : Bio-fertilizer, fertility level, weed management, chickpea, late sown.

Chickpea can be a good alternate crop under late conditions after the harvest of long duration rice crop as well as in areas where irrigation facilities are not available. In recent years, the development of a number of chickpea varieties, suitable for late planting and their introduction in command or rice-fallow areas have opened the avenues of chickpea cultivation under late planting conditions. As late planted crop has low productivity per plant due to restricted vegetative Growth, maintenance of high plant population and management of fertilizers weed and irrigation are the dominant factors for maximizing the potentiality of late sown chickpea. Under late conditions, simultaneous emergence and rapid growth of weeds along with chickpea crop in the field cause severe weed-crop competition for available resources in early stage. Weeds reduce grain yield of chickpea 60% (Anonymous, 1997). The better input management factors are equally responsible for higher biomass production of weeds (Singh, 2007). Since chemical fertilizers are not only in short supply but also expensive, there is need to supplement these with organic sources more particularly bio-fertilizers of microbial origin which are cheaper, pollution free and renewable (Mukherjee and Rai, 2000). Keeping above facts in view, to asses the performance of chickpea as influenced by bio-fertilizers, fertility levels and weed management practices under late sown condition.

MATERIALS AND METHODS

Experiments were conducted on a lowland rice fallow area during winter (*rabi*) season of 2002-03 and 2003-04 at the Agricultural Research Farm of Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The soil was a sandy clay loam with pH 7.5, organic carbon 0.32 per cent, EC 0.18 d S m^{-1}, available soil N 195 kg/ha, available Olsen's P 18.36 kg/ha, available soil K 214.3 kg/ha. The treatments consisted of three bio-fertilizers (*Rhizobium*, vesicular arbuscular mycorrhiza (VAM) and *Rhizobium* + VAM), three fertility levels (75% of recommended dose of NPK, 100% of recommended dose of NPK and 125% of recommended dose of NPK) and three weed management practices (weedy check, pendimethalin 1.0 kg/ha, pendimethalin 0.5 kg/ha + hoeing at 40 days after sowing), thus, making 27 treatment combinations. The experiment was laid out in 33 partial confounded design with 3 replications. Chickpea cultivar KPG-59 was sown in lines with a spacing of 25 cm apart on 9 and December 2002 and 2003, respectively by adopting all recommended package of practices except the treatments. The recommended dose of fertilizer viz. 20 kg N, 50 kg P_2O_5, 20 kg K_2O/ha (100% NPK) was placed through urea, diammonium phosphate and muriate of potash, respectively as basal dose before sowing of seeds. Chickpea seed was inoculated with *Rhizobium* culture at the rate of 20 g/kg of seed. For VAM fungi, *Glomus mosseae* was used for soil inoculation. Pre-emergence application of pendimethalin was applied immediately after sowing the crop with manually operated knapsack sprayer fitted with flat fan nozzle using 600 liters/ha of water. Hoeing as done at 40 days after sowing with the help of hand hoe. The data on weed population and weed dry weight were recorded at 70 days after sowing using 0.5 x 0.5m random quadrate at two places and analysed after subjecting the original data to square root transformation ($\sqrt{(x+0.5)}$). The yield attributes, seed yield and straw yield were recorded treatment-wise at harvest. Economics of the treatment was computed on average of two years data based upon the common cost of cultivation Rs. 7660 /ha, cost of seed Rs.12250 / tonnes and cost of straw Rs. 500 /tonnes, respectively.

RESULTS AND DISCUSSION

The weed flora observed in the experimental field were *Anagallis arvensis* L., *Argemone mexicana* L., *Avena ludoviciana* Dune; *Chenopodium album* L., *Cynodon dacylon* (L.) Pens., *Cyperus rotundus* L., *Melilotus alba* Desr., *Melilotus indica* (L.) All., *Phalaris minor* Retz., *Vicia hirsuta* (L.) S.F. Gray and *Vicia sativa* L. Among the dicot weeds, *Chenopodium album* L. was the predominant weed followed by *Anagallis arvensis* L. and *Vicia sativa* L. during both the years of crop season. *Cynodon doctylon* (L) Pers. and *Avena ludoviciana* Dune. werte the monocot weeds present in both the years.

Effect of bio-fertilizer sources

The exact role of bio-fertilizer on weed growth and development is not known clearly. In the absence of specific function, it is considered to play the role in increasing the availability of nutrients. In the present investigation, effect of bio-fertilizer was found favourable for growth of monocot weeds but did not record a significant increase in population of dicot weeds. Maximum population of dicot and monocot weeds was obtained with the application of VAM in both the years. Similarly, significantly higher dry matter production of weeds under the application of VAM in comparison to *Rhizobium* alone or *Rhizobium* coupled with VAM together, respectively (Table 1). This was due to its extended root system of VAM hyphae and high number of nitrogen fixing bacteria, which help in trapping the moisture and nutrients from the soils. Application of *Rhizobium* + VAM and *Rhizobium* being on par, significantly increased the seed and straw yield of chickpea over the application of VAM alone (Table 2). Kumar *et al.* (1998) also observed improvement in seed yield of chickpea with bio-fertilizer application. Yield attributing characters viz, number of pods/plant and 1000-seed weights were also higher under the dual application of *Rhizobium* + VAM. Application of bio-fertilizers increased seed and straw yields of late sown chickpea thus, increased economic benefits. Amongst bio-fertilizers, the combined application of *Rhizobium* and VAM together showed the highest economic return (1.23) followed by *Rhizobium* (1.22) and VAM (1.08) alone application, respectively in both the years.

Effect of fertility levels

Population of monocot weeds increased significantly with increasing dose of fertilizer from 75 to 125% recommended NPK doses during both the years of study. However, fertility levels failed to have significant influence on dicot weeds population (Table 1). Higher doses of fertilizer accelerated density of weeds

Table 1. Effect of biofertilizer, fertility level and weed management practices on chickpea

Treatment	Dicot weed count (no./m²)		Monocot weed count (no./m²)		Weed dry weight (g/m²)		Yield attributing characters			
							Pods/plant		1000-seed weight (g)	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
Biofertilizer										
Rhizobium	1.98	1.07	3.96	4.03	3.27	3.29	24.98	25.98	150.34	151.03
VAM	2.05	2.14	4.17	4.40	3.43	3.44	24.82	24.82	143.27	144.32
Rhizobium + VAM	1.81	1.88	3.63	3.77	3.10	3.13	25.26	25.26	151.43	152.01
Fertility level										
75% NPK	1.72	1.49	3.00	3.30	2.61	2.63	24.09	24.36	138.29	140.07
100% NPK	1.87	1.59	3.93	4.03	3.35	3.39	24.94	25.07	149.36	148.09
125% NPK	2.25	2.32	4.83	4.87	3.83	3.85	25.32	25.66	156.14	159.20
Weed management										
Weedy check	2.48	2.47	5.65	5.68	4.38	4.40	24.48	24.54	139.53	140.19
Pendimethalin 1.0 kg /ha	2.27	2.28	4.59	4.76	3.62	3.65	25.81	25.29	140.90	150.16
Pendimethalin 0.5 kg /ha + Hoeing at 40 days	1.10	1.35	1.37	1.57	1.09	1.11	25.23	25.63	155.84	157.02
CD (P=0.05)	NS	NS	0.51	0.42	0.22	0.21	0.26	0.30	0.81	0.83

NS: Non Significant

Table 2. Effect of biofertilizer, fertility level and weed management on seed and straw yields and economics of late sown chickpea

Treatment	Seed yield (q/ha)		Straw yield (q/ha)		Net Return (Rs. /ha)	Benefit : cost ratio
	2002-03	2003-04	2002-03	2003-04		
Biofertilizer						
Rhizobium	15.1	16.2	34.7	35.6	11604	1.22
VAM	14.2	15.4	34.0	34.9	10380	1.08
Rhizobium + VAM	15.4	16.5	35.0	36.3	11830	1.23
Fertility level						
75% NPK	13.2	14.0	32.5	33.4	9868	1.07
100% NPK	15.1	16.2	35.1	36.1	11385	1.19
125% NPK	16.3	17.2	36.2	37.3	12560	1.27
Weed management						
Weedy check	13.7	14.9	32.8	33.7	10195	1.12
Pendimethalin 1.0 kg/ha	15.0	16.1	35.0	35.6	11099	1.17
Pendimethalin 0.5 kg/ha + Hoeing at 40 days	16.0	16.6	35.8	37.0	12291	1.24
CD (P=0.05)	0.8	1.0	0.8	1.1		

and proportionally brought about higher dry matter production of total weeds. The increase in dry biomass of weeds at higher level of fertilizer resulted from greater availability of nutrients, which helped in the build up of better vegetative growth. Further, fertility levels influenced the yield parameters during both the years. Increased test weight and pods/plant[1] were recorded at higher fertility level. These results are in agreement with the results obtained by Singh *et al.* (1990). Ali (1994) also reported that the late sown chickpea responds well to higher dose of fertilizer application mainly due to low native rhizobia in rice fields. Use of 125% recommended NPK not only increased the yield attributes but also increased significantly seed and straw yields of chickpea, which showed an edge over no, low and medium fertility treatments. This might be due to easy and greater availability of nutrients in higher levels of fertility. Increasing levels of NPK applied to chickpea increased the net return (Rs. 12560) and benefit: cost ratio (1.27) under 125% recommended NPK dose (Table 2).

Effect of weed management practices

Weed management practices significantly influenced monocot weeds population and weed biomass production but did not cause significant effect on dicot weeds population. Application of pendimethalin 1.0 kg/ha reduced the monocot weeds population and dry weight of weeds significantly compared to weedy check during both the years. This could be explained on the basis of the fact that maximum uptake of dinitroanilines and better entry of herbicide as soon as weeds have emerged. Balyan and Malik (1996) also recommended pre-emergence application of pendirnethalin at 1.0 kg/ha in controlling broad spectrum weeds in chickpea. Supplementing one hoeing at 40 days after sowing along with pendimethalin 0.5 kg/ha registered sharp decline in monocot weeds population and weeds biomass production over sole application of pendimethalin and unweeded check during both the years (Table 1). These results corroborate the findings of Chopra *et al.* (2001). Due to poor growth and effective management of weeds under application of pendimethalin 0.5 kg/ha supplemented with one hoeing at 40 days after sow weeds were unable to compete with the crop plants and resulted in the highest expression of yield attributing characters *viz.* pod/plant and 1000-seed weight, thus, gave higher yield over rest of weed management treatments. Balyan and Malik (1996) also suggested integration of reduced rates of herbicides followed by cultural practices gave higher yield and its attributes in chickpea crop. The higher yield under weed control treatments might be due to reduced state of crop-weed competition, as the plants have to face neither nutrient nor moisture stress due to lower weed infestation. All the weed control treatments were superior in monetary returns over unweeded check. The highest net return (Rs. 12291) and benefit: cost ratio (1.24) were accrued under reduced dose of pendimethalin 0.5 kg/ha coupled with hoeing at 40 days after sowing. The profitability integrated weed management through herbicide followed by cultural practices in chickpea was also reported hby Chopra *et al.* (2001) and Gawai and Pawar (2006).

Interaction effect of fertility levels and weed management practices

Interaction effect of fertility level and weed management significantly affected the yield of

Table 3. Interaction effect of fertility level and weed management practice on seed yield (q/ha) of chickpea (2002-03)

Treatment	Weed management practice		
	Weedy check	Pendimethalin 1.0 kg/ha	Pendimethalin 0.5 kg/ha + hoeing at 40 days
75% NPK	12.44	13.00	14.27
100% NPK	13.95	15.42	16.06
125% NPK	14.68	16.58	17.76
CD at 5%		0.42	

Table 4. Interaction effect of fertility and weed management practice on seed yield (q/ha) of chickpea (2003-04)

Treatment	Weed management practice		
	Weedy check	Pendimethalin 1.0 kg/ha	Pendimethalin 0.5 kg/ha + hoeing at 40 days
75% NPK	13.52	14.22	14.40
100% NPK	15.20	16.56	17.00
125% NPK	15.86	17.50	18.52
CD at 5%		0.51	

chickpea during both the years (Tables 3 and 4). The treatment combination where fertilizer and weed management practices were applied with 125% recommended NPK dose pendimethalin 0.5 kg/ha coupled with hoeing at 40 days after sowing recorded significantly higher seed yield than rest of the combinations. However, the least effective treatment combination in influencing the seed yield was with 75% recommended NPK dose application in weed infected crop.

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EFFECT OF SOWING TECHNIQUES AND WEED CONTROL METHODS ON WEED GROWTH PERFORMANCE OF WHEAT (*TRITICUM AESTIVUM* L.)

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Abstract

A field experiment was conducting was conducted during 2003 to 2004 at the Project Directorate for Cropping Systems Research, Modipuram, Meerut, to find out the most effective weed control method in controlling weed in wheat. Result indicated that stale seedbed resulted in higher wheat yield (4.45 t/ha) as compared to conventional tillage (4.22 t/ha), among weed control treatments, herbicides + one hand weeding (5.34 t/ha) and criss-cross sowing + herbicides + one hand weeding (5.66 t/ha) recorded at par yield but significantly superior to two hand weeding (4.78 t/ha). The highest net return (Rs. 35,505/ha) was recorded under criss-cross sowing + herbicides + one hand weeding and proved to be superior over other methods of weed control.

Key words : Weed control, stale seedbed, herbicide, wheat.

Weeds compete with crop plants for nutrients and other growth factors. The close proximity of weeds and their number causes sub-optimal growth factors, leading to reduction in growth and yield of crop (Reddy and Reddy, 1997). Reduction in yield of wheat due to weeds varies from 7 to 50% depending upon weed density of weed flora present (Kurchania *et al.*, 2000). Identification of effective sowing technique for uniform and optimum distribution of crop plants even with the same seed rate and judicious weed management may act synergistically to minimize the weed-crop competition in time. Keeping these facts in view, the present experiment was carried out to study the effect of weed management on productivity and profitability of wheat under different planting method.

Materials and Methods

The experiment was carried out at the Research farm of the Project Directorate for Cropping Systems Research, Modipuram, Meerut during 2003-2004. The site is located at 29.40" N latitude, 77.4° E longitude and at 237 m above mean sea level, and categorized in hot-dry semi-arid subtropical climate with summers and serve cold winters. The mean annual rainfall of the site is about 700 mm and evapo-transpiration 1600 mm. The soil was sandy loam consisting of 63.7, 19.1 and 17.2 per cent sand, silt and clay, respectively. The soil pH, electrical conductivity, organic carbon, available P and available K, were 8.20, 0.47 dS/m, 037 per cent 3.4 mg/kg and 35 mg/kg of soil, respectively.

Wheat "PBW 343" was grown in two sowing techniques var. i.e. stale seedbed and traditional seedbed in main plots and each main plot was divided into five sub-plots according to weed management treatments viz. hand weeding twice, herbicides + one hand weeding, criss-cross sowing + herbicides + one hand weeding and unweeded check. The crop was sown in line with spacing 20 cm at a seed rate if 100 kg/ha for wheat. The crop was replicated thrice in split-plot design.

For stale seedbed preparation for wheat crop, irrigation was applied in standing rice in third week of October and here after harvesting rice in last week of October two cross harrowing + one cultivator + one planking were performed, thereafter, field was left for germination of weed seeds for about 15 days. After germination of weed seeds, field was finally prepared by resorting to one shallow plowing with cultivator followed by planking. Whereas in traditional seedbed, at sowing time, two harrowing + two cultivator + one planking were done to prepare a well pulverized seedbed. A uniform dose of fertilizer for wheat crop was applied @ 37 kg N, 60 kg P and 60 kg K plus 20 kg Zn per ha as abasal dose and rest nitrogen in two split of 56.5 kg N doses at 30 days after sowing (DAS) was top dressed uniformly on wheat crop. Wheat was planted in 3rd week of November. Weeds were controlled with appropriate herbicides as required in wheat crop and hand weeding according to treatments. Herbicide for post-emergence weeds control included 2,4 D (80 %WP) and isoproturon (Isoproturon 75% WP) was sprayed at a rate of 800 g/ha and 1.25 kg/ha at 30-35 DAS for wheat crop. The first and second hand weeding was done at 30-35 DAS and 50-55 DAS for wheat crop according treatments.

RESULTS AND DISCUSSION

Weed dynamics

The dominant weeds found in the wheat field included common lambsquarters (*Chenopodium album* L.), blue pimpernel (*Anagallis arvensis* L.), sweet clover (*Melilotus indica* L.), fine leaf fumitary (*Fumaria parviflora* L), field bind weed (*Convoluulus arivensis* L.), common vetch (*Vicia sativa* L.), and wild onion (*Asphodelus tenuifolius* L.) among broad leaf weeds and wild canary grass (*Phalaris minor* (L.) Retz.), wild oat (*Aven fauva* L.) durva grasss (*Cynodon dactylon* L.) Pers. and nut sedge (*Cyprus rotundus* L). Number and dry weight of weeds were significantly lower under stale seedbed compared to traditional tillage system. This may be due to early weed seed germination in stale seedbcd preparation later on shallow plowing destroying germinated weed flora. It was observed that use of herbicides + one hand weeding and criss-cross sowing + herbicides + one hand weeding gave similar but significantly higher yield than that of hand weeding twice. Though number of weeds/m^2 was at par among treatments of hand weeding twice, herbicides + one hand weeding + criss-cross sowing and herbicide+one hand weeding, dry weight of weeds was significantly lower in herbicide+one hand weeding and herbicide + one hand weeding + criss-cross sowing (Table 2). Among the weed control treatments, hand weeding recorded significantly higher weed population and weed dry biomass than chemical weeding. This was due to the growth of surviving weeds and resurgence of weed population with new flushes of weed growth. The higher weed biornass was due to early stage and first flash of weeds, which could not attend full growth under the shade of crop canopy. The results confirm the findings of Dixit and Bhan (1997, and John and Singh. 1991).

Yield and yield attributes

The results indicated that the stale seedbed produced higher yield as compared to conventional tillage (Table 1). Among weed control treatments, herbicide + one hand weeding + criss-cross sowing and herbicide + one hand weeding gave similar yield but significantly superior to two hand weeding (4.78 t/ha). Stale seedbed preparation resulted in significantly higher number of effective tiller/m^2 compared to traditional tillage, number of effective tillers/m^2 was significantly higher with criss-cross sowing + one hand weeding + herbicide treatment. Ear length. ear weight and 1000-grain weight were numerically higher in stale seedbed than traditional seedbed preparation. Among weed control treatments, herbicide + one hand weeding and criss cross sowing, herbicide + one hand weeding and hand weeding twice resulted in similar yield atthbutes but significantly higher than one hand weeding and unweeded check (Table 2). These findings confirm the results of Saini *et al.* (2001).

Monetary returns

The net returns was higher in stale seedbed compared to traditional seedbed preparation. However,net return was slightly increased during 2004. Among the weed management practices, highest net return was recorded under criss-cross sowing + herbicide + one hand weeding followed by use of herbicide + one hand weedingbut resulted in higher net returns than two hand weeding. Similar results were also reported by Sharma (2003).

Table 1. Effect of seedbed preparation and weed management practices on grain yield and net return wheat crop

Treatment	Grain yield (t/ha)			Net return (Rs/ha)		
	2003	2004	Over all mean	2003	2004	Over all mean
Sowing techniques						
Sate seed bed	4.37	4.52	4.45	25773	26001	25887
Traditional seed bed	4.13	4.30	4.22	23676	24362	24019
CD at 5%	NS	NS	-	-	-	
Weed control						
Hand weeding twice	4.63	4.93	4.78	26250	26359	26305
Herbicides + hand weeding once	5.46	5.82	5.64	34337	35201	34769
Criss-cross sowing+hand	5.56	4.69	4.63	26426	24775	25601
weeding once	5.59	5.72	5.66	35572	35438	35505
Criss-cross sowing+	0.92	0.89	0.91	10.39	4134	2587
herbicides+hand weeding once	0.35	0.34	-	-	-	-
Unweeded check						
CD (p=0.05)						

Table 2. Effect of sowing techniques and weed management practices on weed dynamics and yield attributes of wheat

Treatment	Number of weeds /m²		Dry weight of weeds (g)		Weed efficiency %		No. of effective tiller /m²		Ear length (cm)		Ear wt. (g)		1000 grain wt. (g)	
Sowing techniques	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
Stale seed bed	127	128	191	192	74	75	365	365	15.9	16.2	2.88	2.93	36.2	36.7
Traditional seed bed	156	154	223	223	72	71	363	359	15.6	15.7	2.90	2.83	36.1	36.3
CD (P=0.05)	18	12	9	23	-	-	NS	5	NS	0.52	NS	NS	NS	NS
Weed control														
Hand weeding twice	18	16	47	44	94	94	433	435	17.0	16.8	3.05	3.18	38.5	38.7
Herbicides + hand weeding once	1	1	4	2	99	100	451	445	17.2	17.8	3.24	3.28	38.5	39.0
Criss-cross sowing + hand weeding once	79	74	211	206	73	73	410	404	16.6	16.3	3.19	3.12	38.2	38.3
Criss-cross sowing + herbicides+ hand weeding once	2	1	6	4	99	99	450	452	17.1	17.8	2.88	2.93	38.7	39.1
Unweeded check.	609	610	768	782	0	0	77	74	10.8	10.8	2.90	2.83	27.0	27.3
CD (P=0.05)	29	20	29	25	-	-	19.59	14.60	0.68	0.46	NS	NS	0.39	0.26

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EFFECT OF NITROGEN LEVELS AND SPACING ON YIELD ATTRIBUTES, YIELD AND QUALITY PARAMETERS OF BABY CORN (*ZEA MAYS*)

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ABSTRACT

A experiment was conducted during *rabi* season during 2005-06 on lateritic soil, at Agronomy Farm, College of Agriculture, Dapoli, to study the effect of nitrogen levels (0,50,100,150 and 200 kg ha and spacing (60x20cm, 45x20cm and 30x20cm) on the performance of yield attributes,yield and quality parameter of baby corn study revealed that spacing 60 x 20 cm was pat par with 45 x 20 cm recorded significantly higher values of yield attributing characters over the spacing of 30 x 20 cm. The spacing of 45 x 20 cm recorded significantly higher baby corn yield with and without husk than the remaining spacing's. The length of baby corn cob, number of cobs per plant and baby corn (cob) weight without husk increased significantly with the increase in nitrogen levels up to 150 kg/ha. Application of 200 kg N/ha recorded significantly higher baby corn yield with husk, green fodder yield and total biomass production (q/ha) than rest of the nitrogen levels. The wider spacing of 60 x 20 cm recorded significantly higher protein and sugar content than the narrower spacing. Application of 200 kg N/ha recorded significantly higher protein %, in baby corn than rest of the nitrogen levels. The further application of 150 kg/ha and 200 kg/ha nitrogen were at par and recorded significantly higher sugar content than the remaining nitrogen levels *viz.* 100 k/ha, 50 k/ha and control.

Key words : Baby corn, nitrogen levels, spacing, yield, and yield attribute, quality.

Maize is classified in to different groups or types based on the endosperm of kernels among which baby corn (*Zea mays*) is grown for vegetable purpose. This venture isd enormously successful in countries like Thailand, Taiwan, Srilanka and Myanmar. In India, cultivation of baby corn is of recent development. Its cultivation is now picking up in a serious way in Meghalaya, western Uttar Pradesh, Harayana, Maharashtra, Karnataka and Andhra Pradesh (Ramachandrappa *et al.* 2004). Fresh baby corn has a crisp texture and a subtle; slightly sweet corn flavor and produces delicious treat to eat raw or cooked in many recipes for the preparation of special soups, jams, cream, pickles and other delicious eatables.

Corn is an exhaustive crop and its requirement for fertilizers especially for nitrogen is prominent. Nitrogen is essential constituent of chlorophyll, protoplasm and enzymes and it governs utilization of phosphorus and potassium. It is an important factor for boosting up the yield of cereals and is very important for vegetative growth as well as higher yield (Shrivastava and Sinha, 1992). Next to soil fertility another factor of almost equal importance is plant spacing, because maize crop is less capable of adjustment to a thinner stand than other members of grass family. The review indicated the highest baby corn yield under close spacing (40X40 cm) because highest plant density produced more number of cobs/ha (Thakur *et. al.,* 2000).

MATERIALS AND METHODS

A field experiment was conducted at Agronomy Farm, College of Agriculture, Dapoli, Dist. Ratnagiri (M.S.) during rabi season of the year 2005-06 on a sandy loam and slightly acidic soils. It was medium in available nitrogen and phosphorus and moderately high in potassium content. There were 15 treatment combinations replicated thrice in a split plot design. Which comprised of three spacing (60x20cm, 45x20cm and 30x20cm) assigned to main plots, while five levels of nitrogen (0,50,100,150 and 200 kg/ha allotted to sub-plot treatments. The baby corn cultivar G-5406 was used in the present investigation. Seeds were sown as per different levels of spacing. Two seeds were dibbled at each spot at about 5 cm depth. After sowing, seeds were covered with soil and gap filling was undertake/immediately 8 DAS to maintain uniform plant population whenever necessary. Similarly, thinning was carried out at 13 DAS in order to maintain one plant per hill. The irrigations were given at an interval of 12 to 15 days. First irrigation was given immediately after sowing. In all six irrigations were given.

Well decomposed farm yard manure (FYM) @ 10 t/ha was uniformly applied in each plot and mixed thoroughly into the soil at the time of land preparation. Nitrogen, phosphorus and potash were applied in the form of urea (46.4 % N), single super phosphate (16 % P_2O_5) and muriate of potash (60% K_2O), respectively. Uniform recommended dose of phosphorus @ 60 kg/ha and potassium @ 40 kg/ha were applied as a basal dose at the time of sowing. Nitrogen was applied as per the treatments. Out of the total nitrogen 50% N was applied as a basal dose at the time of sowing and remaining 50% N at 25 DAS.

Tassels were removed from all the plants at 70 DAS. The cobs were picked at green stage from the standing crop. The cobs from ring were removed separately to remove the border effect. The weight of green cobs and other observation of green cobs were recorded from the net plot. After removing the green cobs from the plants, the fodder was harvested and green biomass weight was recorded from the net plot. In order to assess the effect of different treatments on the growth and development of the experimental crop, periodical observations were recorded.

RESULTS AND DISCUSSION

Effect of spacing

Data from Table 1 revealed that different spacings significantly influenced the length of baby corn, number of cobs per plant, baby corn (cob) weight with husk and baby corn (cob) weight without husk. The wider spacing 60 x 20 cm, which was pat par with the spacing 45 x 20 cm recorded significantly higher values of the entire above referred yield attributing characters over the spacing of 30 x 20 cm. Further spacing of 45 x 20 cm was also significantly superior to the spacing 30 x 20 cm in respect of all the yield attributing characters. The different spacing treatments influenced the baby corn yield with and without husk, baby corn yield, green fodder yield and total biomass production significantly. The spacing of 45 x 20 cm recorded significantly higher baby corn yield with husk and baby corn yield than the remaining spacing. It was followed by 30 x 20 cm and 60 x 20 cm spacing in the order of significance. In case of green fodder yield and total biomass production, the spacing 30 x 20 cm was produced significantly higher green fodder yield and total biomass production which was significantly superior over the remaining treatment *viz.* 45 x 20 cm and 60 x 20 cm. Further, spacing of 45 x 20 cm also recorded significantly higher green fodder yield and total biomass production yield than the spacing of 60 x 20 cm. The crop under the closer spacing of 45 x 20 cm has utilized all the resources efficiently and hence, the size of source and sink per unit area was larger under it and it declined progressively with the increase in the spacing and the lowest values were recorded under the broader spacing of 60 x 20 cm. This has further resulted into production of significantly higher per hectare baby corn yield under the closer spacing of 45 x 20 cm than the broader spacing. It was followed by 30 x 20 cm and 60 x 20 cm in the order of significance similar results were reported by Thakur *et al.* (2000). However green fodder yield and total biomass production significantly more under the 30 x 20 cm spacing. Similar findings were reported by Thakur *et al.* (1997) and Sukanya *et al.* (1999). The wider spacing of 60 x 20 cm recorded significantly higher protein and sugar content than the narrower spacing of 45 x 20 cm and 30 x 20 cm. Further 45 x 20 cm and 30 x 20 cm spacing were at par with each other in respect of both quality parameters.

Effect of nitrogen

It was revealed from the data presented in Table 1 that baby corn yield with husk, baby corn yield, green fodder yield and total biomass production increased significantly with the subsequent increase in the nitrogen level.

Therefore, application of 200 kg N/ha recorded significantly higher baby corn yield with husk, green fodder yield and total biomass production than rest of the nitrogen levels. It was followed by 150 kg N/ha 100 kg N/ha, 50 kg N/ha and control in the order of sequence. However, application of 200 kg N/ha gave the highest baby corn yield which was significantly higher than that of 0 to 100 kg N/ha and no significant differences were obtained between 150 and 200 kg N/ha which was at par with each other. The beneficial effects of the higher levels of nitrogen to baby corn in terms of dry matter accumulation ultimately reflected in increasing the yield attributing characters, the higher availability of source under the higher nitrogen levels created more sink than the nitrogen lower level. Similar findings were obtained by Pandey *et al.* (2000). Application of 200 kg N/ha recorded significantly higher protein content of baby corn than the remaining nitrogen levels. Further application of 150 kg ha^{-1} and 200 kg/ha nitrogen were remained at par and recorded significantly higher sugar content than the remaining nitrogen levels *viz.* 100 k/ha, 50 kg/ha and control. As nitrogen is the basis constituent of protein, the higher concentration of nitrogen in the baby corn resulted into synthesis of more protein and higher availability of resources and better photo-synthetic and other physiological activities of the individual plant under sugar the broader spacing of 60 x 20 cm. Similar results were found by Kunjir (2004) and Ramchandrappa *et al.* (2004)

Interaction effect

Among the interactions, spacing and nitrogen levels was found significant in respect of baby corn yield, green fodder yield and total biomass production.

Table 1. Interaction effect of spacing and nitrogen levels on baby corn yield (q/ha)

	Nitrogen levels (kg/ha)				
Treatments	Control	50	100	150	200
Spacing					
60 x 20 cm	8.87	12.34	16.22	18.54	18.86
45 x 20 cm	10.08	14.36	17.03	22.53	22.19
30 x 20 cm	9.38	12.83	16.62	20.09	20.36
			SEm ±	CD at 5%	
Between the levels of spacing at the same level of nitrogen			0.26	0.94	
Between the levels of nitrogen at the same level of spacing			0.19	0.56	

Table 2. Interaction effect of spacing and nitrogen levels on the total biomass production (q/ha) of baby corn

	Nitrogen levels (k/ha)				
Treatments	Control	50	100	150	200
Spacing					
60 x 20cm	211.78	279.52	341.76	362.91	385.89
45x20cm	233.96	299.80	360.28	412.95	444.23
30 x 20 cm	239.79	312.59	373.59	431.01	491.25
			SEm±	CD at 5%	
Between the levels of spacing at the same level of nitrogen			6.13	19.33	
Between the levels of nitrogen at the same level of spacing			6.01	17.54	

The treatment combination of 45 x 20 cm spacing with 200 kg N/ha was at par with 45 x 20 cm spacing with 150 kg N/ha and recorded signi-ficantly higher baby corn yield (Table 2) than the remaining treatment combinations.

The that treatment combination of 30 x 20 cm spacing with 200 kg/N/ha. The treatment combination of 30 x 20 cm spacing with 200 kg/ha recorded significantly more total biomass production of baby corn than the other treatment combinations. Further treatment combination of 30 x 20 cm spacing with 150 kg N/ha and 45 x 20 cm spacing with 200 kg N/ha were at par and also produced more total biomass production over the rest of treatment combinations.

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WEED FLORA DISTRIBUTION AND ITS ETHINOBIOLOGICAL VALUE IN RAINFED RICE ECOSYSTEM UNDER MID HILL SITUATION

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Abstract

A survey on weed flora and their distribution pattern in the Kalimpong and its adjoining rice growing area had been observed over a period of three years (2006-2008) in *kharif* season. Detail studies on the life cycle, mode of propagation, nature of stem, leaf structure and economic value of the most common weeds species have been seen. Forty eight weed spp. Were identified belonging to 28 families in this region which comprised of 62% if the total weed population. A number of weeds have the medical vlue of great importance. Regarding family-wise contribution *Poaceae* contributing highest number (9) in hill which are useful for food and fodder purpose followed by *Cyperaceae* (4), *Amaranthaceae* (3), *Commelinaceae* (3) and *Euphorbiaceae* (3). Most of the weeds were propagated by seeds and few of them by vegetative means. Ethenobiological studies revealed that, these weeds were very helpful for various medical treatments. Local peoples particularly *Lepcha, Bhutia* and *Tibetans* used this weed herb as folk medicine for various disease.

Key words : Rainfed rice, weed flora, ethinobiological value.

Weeds are a global, ubiquitous influence of agriculture. We cannot address the major challenge to agricultural development food security, environmental degradation, and poverty if we fail to address problem related to weed in farmer's aware their economic value then it will not be treat as weed then it will turn down to an economic plant. Weed in the history of agriculture have been a mixed blessing.

Several known weed have been put to certain economic use since ages. Of these, their medicinal use is perhaps the most ancient one of India (Jain, 1968). Many weeds have made good contribution to the development of ancient India Materia medica. The Charaka Samhita, one of the earliest treaties on Indian medicine records the use of several drugs of weed origin. Even now tribal doctors gather several weeds to meet the demand of their medicinal profession in remote village (Gupta, 2003). Several rice weeds are extensively used as pot herb in rural India. The information on its ethobotanicl value of rice weeds in rainfed ecosystem under mid hill situation is very scanty. It is very important for farmer to know about weeds and its importance in present context. In view of the above facts, present study was undertaken to know the weed flora present in rice field and their ethnobiological value in farmer perspective.

Materials and Methods

The floristic studies of weed communities under mid hill rice ecosystem were conducted during the *kharif* season of 2006-07 and 2007-08, at Regional Research station (Hill Zone), Uttar Banga Krishi Viswavidyalaya, Kalimpong (1250 m) and its adjoining area. Surveys are mostly confined to sandy loam type of soil. Day to day survey of all kinds of rice weeds was made in different land situation i.e. rice fields and file bunds. Each species were collected and morphological characteristics, life cycle, habitat and ethnobiological values were noted after proper identification. The nomenclature and author citation of the species was done as per Moody (1981) and Nayarko (1991). Several ayurvedic doctors and Pundit were consulted for the proper identification of medicinal, aesthetic and food value of weeds.

Table 1. Morphological characteristics and ethnobiological value of weeds in rainfed rice ecosystem under mid hill situation in Kalimpong.

Botanical name	Common name	Family	Life cycle	Propagation	Leaf structure	Season of abundance	Ethnbiological value
Ageratum conyzoides L.	Tropic ageratum	*Asteraceae*	A	S	BL	KZ	Nervine tonic, decoction in flatulence
Amaranthus spinosus L.	Spiny amaranth	*Amaranthaceae*	A	S	BL	KZ	Febrifuge lactgogue, lactagogue, emollient and pot herb
Amarnthus viridis L.	Slender amaranth	"	A	S	BL	KZ	Pot h herb, shoots used in eczema.
Ammania haccifera(L.) Rottb	Jangal mehandi	*Lythraceae*	A	S	NL	K	Fodder for cattle
Celosia argentia L.	Cocks comb	*Amaranthaceae*	A	S	BL	KZ	Seeds in diarrhea, eye trouble and sore mouth
Centella asiatica (L.)Urban	Indian pennywort	*Apiaceae*	P	S/VP	BL	KR	Diuretic, tonic and treatment in leprosy
Commelina benghalensis L.	Day flower	*Commelinaceae*	A	S	BL	KR	Starcy rhizomes demulcent, laxative and emollient
Commelina diffusa Burm F.	Spreading day flower	"	A	S	BL	KRZ	Fodder for cattle
Corchorus acutangulus Lam.	Wild sesame	*Tiliaceae*	A	S	BL	KRZ	Leaves consumed as tonic
Cyanotis axillaries (L.) D. Don	Cyanotis	*Commelinaceae*	A	S	BL	KZ	Seeds edible, used in tympanitis and ascties
Cynodon dactylan (L.) Pers.	Bermuda	*Poaceae*	P	S/VP	NL	KRZ	Decoction dicuretic, rhizomes in geneto-urinary disorders
Cyperus difformis L.	Umberella sedge	*Cyperaceae*	P	S	NL	KRZ	
Cyperusmicro-iria Stud.	Flat sedge	"	A	S	NL	KR	Ionic, stomachic
Cyperus rotundus L.	Purple nut sedge	"	P	S/VP	NL	KRZ	Astringent, diarrhea
Dactyloctenium aezypticum (L.) Richt.	Crow foot grass	*Poaceae*	A	S	NL	K	Diuretic, diaphoretic and bowel complaints
Datura stramonium (L.)	Jimson weed	*Solanaceae*	A	S	BL	KR	Grains used as food by tribal
Digitaria sanguinalis (L.) Scop	Crab grass	*Poaceae*	A	S	NL	KRZ	Narcotic, antispasmodic
Echinochloa colona (L.) Link	Jungle rice	"	A	S	NL	KRZ	Fodder for cattle
Echinochloa crusgalli (L.) Beauv	Awned barnyard	"	A	S	NL	KRZ	Nutritious fodder for cows
Echinochloa glabrescence (L.) Munro ex Hook	Barnyard grass	"	A	S	NL	KRZ	Fodder grass, used in constipation
Eclipta alba (L.) Haask	False daisy	*Asteracea*	A	S	BL	KRZ	Food grain at scarcity, fodder for cattle
Elusine indica (L.) Gaerton	Goose grass	*Poaceae*	A	S	NL	KRZ	Hepatic and spleen enlargement, skin diseases
Euphorbia hirta L.	Garden spurge	*Euphorbiaceae*	A	S	BL	KRZ	Nutritious fodder for cattle
Fimbristylis miliacea (L.) Rahl	Fimbristylis	*Cyperaceae*	A	S	NL	KR	Cough, asthma, urinary disorders, leaves as pot herb
Ludwigia parviflora Roxb	Water purslan	*Onagrateae*	A	S	BL	KZ	Roots in dysentery Medicinal importance
Panicum repens L.	Debhar	*Poaceae*	A	S	NL	K	Nutritious for silage making
Paspalum serobiculatum Berg.	Sour paspalum	*Poaceae*	A	S	NL	K	Decobstruent, stomachic
Phyllanthus niruri L.	Niruri	*Euphorbiaceae*	A	S	BL	K	Fodder liked by cattle

A-annual; S-Seed; BL-Broad-leaved; K-kharif; A-Zaid; P-Perennial; VP-vegetatitve propagation; NL-Narrow leaved; R-Rabi.

RESULTS AND DISCUSSION

Studies revealed that 48 common weed species belonging to 25 families were observed. Of the 48 weed species, local people used 28 weeds for medical, food and fodder purpose (Table 1). A number of weeds have the medicinal value of great importance. Regarding family-wise contribution *Poaceae* contributing highest number of species (9) which are useful for food and folder purpose following by *Cyperaceae* (4), *Amaranthaceae* (3), *Commelinaceae* (3, and *Euphorbiaceae* (3) (Table 2). Similar pattern of weed flora distribution had been observed by De and Mukhopadhyay (1984). Nearly 16 herbs were used as local medicines for folk doctors for curing alimentary canal and skin disorder. Three species belonging to *Amaranthaceae* and one species from *Euphorbiaceae* were extensively used as pot herb for rural poor. Fodder needs of cattle and goats were meeting with the all 9 species of *Poaceae* family.

With regard to life cycle, there were 24 annual and 4 perennial weeds. As far leaf structure was concerned, 14 weeds were broad-leaved and 14 species had narrow-leaved. Regarding seasons of abundance, most of the weeds emerge in *kharif* followed by *rabi* and *zaid* season.

Table 2. Number of economic weed species found in each family

Botanical family	No. of species of economic use
Amaranthaceae	3
Aplaceae	1
Asteraceae	2
Commelinaceae	3
Cyperaceae	4
Euphornbiaceae	2
Lythraceae	1
Poaceae	9
Solonaceae	1
Tiliaceae	1
Total	28

The alkaloids, metabolites and other complex chemical substances that are responsible for curing the disease and have aesthetic importance need to be identified for the use of pharmaceutical industry and for domestic purpose also.

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STUDIES ON ROOTING PATTERN OF ACID LIME BY ROOT EXCAVATION

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ABSTRACT

Distribution of roots at different distances from the tree trunk viz. 0-60 cm, 60-120 cm and 120-180 cm and soil depths viz. 0-25 cm, 25-50 cm and 50-75 cm were studied using the root excavation method in seven years old acid lime. The root distribution pattern is influenced by the distance from tree trunk, the soil depth and the season of excavation. It was observed that root density was found maximum at nearest radial distance from tree trunk i.e. 0-60 cm. (86.07 per cent and 62.46 per cent during post rainy and spring season, respectively) and an increase in distance from the tree trunk resulted in reduction of root density considerably. During post rainy season, roots were maximum at 0 to 25 cm, followed by 50 to 75 cm and 25 to 50 cm soil depths. During the spring season, the quantity of roots decreased with an increase in soil depth. Root density was higher during the post rainy season than in spring at different distances from the tree trunk. Feeder roots (< 0.2 cm in diameter) and medium (> 0.5 - 1.5 cm in diameter) roots were maximum as compared to thin (> 0.2 - 0.5 cm in diameter) and thick (> 1.5 cm in diameter) roots in acid lime.

Key words : Acid lime, rooting pattern.

Although time consuming and labour intensive, root excavation methods are widely used for the study of root distribution patterns in fruit trees, root excavation methods are mechanically simpler and require instruments which are ordinarily available at the site of the experiments. It has been experimentally proven that root distribution pattern varies from region to region and is influenced by such factors as age of plant, season of the year, plant species, fluctuation in water table and properties of soil. A powerful root system, its wide and deep distribution in the soil and a persistent and adequate annual growth of absorbing roots are the principal prerequisites of abundant fruit bearing. Root distribution studies has assumed greater significance as these studies indicate the root distribution pattern of fruit trees and are helpful in placement of manure and fertilizers and application of irrigation in the orchards. Establishment and optimum productivity of fruit trees largely depend upon the growth and proliferation of their root system. Root distribution pattern of particular fruit tree differs from place to place and depends upon various factors such as type of soil, fertility tatus, texture, environmental conditions and cultivars etc. There are reports available on determination of rooting pattern by root excavation in citrus (Chandra and Yamadagni, 1983 and Chandra and Yamadagni, 1997) at Hissar and in ber by Pareek (1977) in arid region of Rajasthan. Such studies are required to be conducted at different areas of arid region of all major growing fruit crops. Precise information on root spread and penetration of roots in the soil of fruit trees under arid conditions is of vital importance to decide proper plant densities, area and depth of irrigation, application of manures and fertilizers, and intercultural operations such as hoeing, ploughing, weeding and inter-cropping with short duration crops. Therefore, present investigation greatly helps to suggest efficient use of manures and fertilizers and the extent of fruit cultivation possible in the areas falling under Sikar district of Rajasthan.

MATERIAL AND METHODS

Experiment was carried out on 7 year old trees of acid lime during post rainy and spring season at farmer's orchard in Sanwalod village in Sikar district of Rajasthan. Three uniform trees were selected for excavation. In each experimental tree of acid lime, In each tree a circular with a radius of 1.8 meter from the tree trunk was marked and soil was excavated from 1/4th portion of the area of the circle. The 1.8 meter was further divided into 0-60 cm (R_1), 60-120 cm (R_2), 120-180 cm (R_3) portions. Each portion was excavated for three depths viz., 0-25 cm (D_1), 25-50 cm (D_2) and 50-75 cm (D_3). The data on vigour of experimental trees are given in Table 1. The roots were collected from each combination of depth and radial distance separately and washed. After washing the roots were graded in four categories on the basis of their diameter. The roots diameter was measured by a vernier calipers and then divided into four categories, (i) less than 0.2 cm diameter (T_1), (ii) more than 0.2 cm to 0.5 cm diameter (T_2),(iii) more than 0.5 cm to 1.5 cm diameter (T_3) and (iv) more than 1.5 cm diameter (T_4). These categories were designated as feeder, thin, medium and thick, respectively.

The roots were kept in an oven at 7° C for 72 hours for drying and were then weighed. The density of roots on dry weight basis was calculated in terms of per cubic meter volume of soil. The density of roots on dry weight basis was obtained by multiplying the quantity of dried roots (g) obtained at 0-60 cm, 60-120 cm and 120-180 cm radial distances in acid lime with 14.1542, 4.7180 and 2.8308, respectively. In case of types of roots in acid lime, it was obtained by multiplying the amount of roots obtained (g) at 0-60 cm, 60-120 cm and 120-180 cm radial distances with 4.7180, 1.5726 and 0.9436, respectively. The distribution of roots on weight basis at different radial distances and soil depths was tested in factorial RBD experiment, Meteorological data of temperature and relative humidity during the experiments were collected from the meteorological observatory at Agricultural Research Station, Fateh pur Shekhawati, Distt. Sikar (Rajasthan).

RESULTS AND DISCUSSION

It is clear from the data presented in Table 2 that at R_1 during spring season significantly higher amount of roots were found as compared to other distances from tree trunk. Amount of roots at R1 was 62.46 per cent followed by 24.22 per cent at R2 and 13.31 per cent at R3. During post rainy season also distribution of roots was in the same trend and 86.07 per cent of total roots were found at R1 followed by 10.77 per cent at R2 and 3.16 at R3 (Table 2). Similar observations have been reported by Chandra and Singh (1979) in Eureka lemon, Chandra and Yamdagni (1997) in Kinnow Mandarin and Bhatnagar and Chandra (2001) in Ber where root density was much higher at the nearest distance from tree trunk taken in excavation studies.

It is also obvious from the data presented in Table 2 that during spring 38.36 per cent of total roots was found at D_1 soil depth followed by D_2 (34.00 per cent) and D_3 (27.65 per cent). During post rainy season also significantly higher amount of roots was present at D_1 (35.81 per cent) followed by D_3 (33.22 per cent) and D2 (30.97 per cent) as shown in Table 2. The present studies also indicate that maximum amount of roots was found at a surface soil layer i.e. 0-25 cm depth. Similar findings have been reported by Aiyappa and Srivastava (1965) in coorg mandarin trees, Pareek (1977) in ber, Chandra and Yamdagni (1997) in Kinnow mandarin, Bhatnagar and Chandra (2001) in ber cv. Gola.

Data presented in Tables 3 and 4 revealed

Table 1. Vigour of experimental trees of acid lime at the commencement of root excavation

Plant height (cm)	**Spread of tree (cm)**	
	North to South	**East to west**
252	361	343
291	298	276
303	349	361

Table 2. Distribution of roots in acid lime at different radial distances from tree trunk and at varying soil depths during spring and post-rainy season (g/m^3 of soil volume)

Distance from tree Tank (cm)	Soil depth (cm)			
	0-25 (D_1)	25-50 (D_2)	50-75 (D_3)	Mean
		Spring season		
0-60 (R_1)	1943.85 (24.60%)	1717.39 (21.74%)	1273.88 (16.12%)	1645.04 (62.46%)
60-120 (R_2)	775.34 (9.81)	591.33 (7.48)	547.29 (6.93%)	637.99 (24.22%)
120-180 (R_3)	311.39 (3.94%)	377.34 (4.78%)	363.18 (4.60%)	350.64 (13.31%)
Mean	1010.19 (38.36%)	895.35 (34.00%)	728.12 (27.65%)	350.64(13.31%)
CD at 5% : depth (D) = 71.55; distance (R) = 71.55; interation (RxD) = 123.922				
		Post-rainy season		
0-60 (R_1)	8445.39 (31.77%)	6902.56 (25.96%)	7534.80 (28.34%)	7627.58 (86.07%
60-120 (R_2)	992.37 (3.73%)	990.80 (3.73%)	880.71 (3.31%)	954.62 (10.77%)
120-180 (R_3)	82.09 (0.31%)	341.59 (1.28%)	416.14 (1.57%)	279.94 (3.16%)
Mean	3173.29 (35.81%)	2774.98 (30.97%)	2943.88 (33.22%)	
CD at 5% : depth (D) = 226.92; distance (R) = 226.92; interation (RxD) = 393.043				

Table 3. Distribution of different types of roots at different radial distances from tree trunk in acid lime trees on the basis of dry weight of roots (g/m of soil volume) during spring season

Root diameter (cm)	Distance from tree trunk (cm)			
	0-80 (R_1)	80-160 (R_2)	160-240 (R_3)	Mean
<0.2 (t_1)	1580.56 (20.90%)	574.03 (7.59%)	273.64 (3.62%)	809.41 (32.11)
>0.2 - 0.5 (t_2)	863.41 (11.42%)	242.19 (3.20%)	63.85 (0.84%)	389.81 (15.46%)
>0.5-1.5 (t_3)	2763.22 (36.54%)	238.89 (3.16%)	69.82 (0.92%)	1023.98 (4062%)
>1.50 (t_4)	835.10 (11.04%)	58.18 (0.77%)	0.00 (0.00%)	297.76 (11.81%)
Mean	1510.57 (79.89%)	278.32 (14.72%)	101.83 (5.39%)	
CD at 5% of distance (R)		43.70		
CD at 5% of type of rools (t)		37.85		
CD at 5% of interctuib (Rxt)		75.96		

Table 4. Distribution of different types of roots at different radial distances from tree trunk in acid lime trees on the basis of dry weight of roots (g/m^3 of soil volume) during post-rainy season

Root diameter (cm)	Distance from tree trunk (cm)			
	0-80 (R_1)	80-160 (R_2)	160-240 (R_3)	Mean
<0.2 (t_1)	2175.03 (24.48)	616.49 (6.94%)	216.71 (2.44%)	1002.74 (33.85%)
>0.2 - 0.5 (t_2)	1075.03 (12.11)	170.37 (1.92%)	69.19 (0.78%)	438.43 (14.80%
>0.5-1.5 (t_3)	3365.57 (37.88)	155.69 (1.75%)	44.03 (0.50%)	1188.43 (40.12%)
>1.50 (t_4)	997.08 (11.22%)	0.00 (0.00%)	0.00 (0.00%)	332.36 (11.22%)
Mean	1903.35 (85.68)	235.64 (10.61)	82.48 (3.71%)	
CD at 5% of distance (R)			99.86	
CD at 5% of type of rools (t)			86.48	
CD at 5% of interctuib (Rxt)			172.96	

thaton dry root weight basis feeder and medium types of roots comprise 72.73 and 73.97 per cent of total roots during spring and post rainy season, respectively. Thin roots were also maximum at the nearest distance from tree trunk and it decreased as distance from tree trunk increased during both the seasons. Thick type roots were also found maximum at 0 - 60 cm from tree trunk in both the seasons. These were absent at 60 - 120 cm and 120 - 180 cm distance from tree trunk in post rainy season and at 120 - 180 cm distance from tree trunk in spring season.

The interaction between radial distance and types of roots indicate that maximum quantity of roots at R_1 was of t_3 type of roots (> 0.5 - 1.5 cm diameter) i.e. 36.54 and 37.88 per cent which were significantly higher than the other three types of roots i.e. t_4, t_2 and t_1 in spring and post rainy season, respectively. At R_2 radial distance, maximum quantity of roots was of t1types which were also significantly higher than the t_4, t_3 and t_2 types of roots in both seasons.

It was observed that amount of feeder roots was more during post rainy season as compared to spring season in acid lime. This could be attributed to high temperature during March month. Poor soil might have inevitably caused reduction in the amount of roots during spring season. Comparison of feeder root density during both the season revealed that it was much higher during post rainy season as compared to spring season. The mean values of feeder roots of all the three radial distances during post rainy season were 1002.74 (33.85%) which was much higher than the mean value of feeder roots during spring season i.e. 809.41 (32.11%). It might be due to the congenial conditions for better top and root growth under north Indian condition and it coincides with active growth period of leaf, flower and fruit development and good moisture availability during post rainy season.

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ECONOMIC FEASIBILITY AND WATER PRODUCTIVITY BY ALTERNATIVE CROPPING SEQUENCES TO SUGARCANE UNDER DIFFERENT IRRIGATION METHODS

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ABSTRACT

A field experiment was conducted during 2005-07 to evaluate economic feasibility and water productivity by alternative cropping sequences to sugercane under different irrigation methods at Rahuri. Drip irrigation method recorded significantly more sugarcane equivalent yield, production efficiency, economic efficiency, returns per day and returns per ha-cm of water than other irrigation methods. The adoption of brinjal-chilli sequence saved 19.89 percent water over sugarcane and significantly increased water productivity, return per rupee invested on fertilizer and irrigation than sugarcane and cotton-beet root sequence. It is concluded that, the brinjal-chilli sequence produced significantly more returns per rupee invested on fertilizer, return per day, ha-cm of water under drip irrigation. Hence, it is economically more feasible than sugarcane and cotton beet root-sequence under drip irrigation.

Key words : Irrigation methods, cropping sequences, economic feasibility, water use productivity.

In India per capital water availability has declined to one third of 1951. The water use efficiency of Indian agriculture is about 30 to 40 percent one of the lowest in the world against 55 percent, in china (Anonymous, 2005). It has been estimated that abut 250 tones of water is required to produced one ton of cane (Gupta and Tripathi,1998). The advanced micro irrigation method introduced recently such as drip, microsprinkler, and irrigation through subsurface porous pipe increase the productivity of crop and also save the water. In view of sharply shooting prices many farmers are adding vegetables to crop rotations and their water requirement is less (50-90 ha-cm). Due to their diversity and relatively short duration they can be easily incorporated in many cropping systems. Focusing, the attention on increasing the cropping intensity as well as production per unit area, per unit drop per unit time is now gaining importance. Change in cropping pattern not only brings the change in farming but also influence social and economical activity of farmer. Therefore, the present study was undertaken to evaluate economic feasibility and water productivity by alternative cropping sequences to sugarcane under different irrigation methods.

MATERIALS AND METHODS

A field experiment was conducted during 2005-06 and 2006- 07 at All India Co-ordinated Research Project on Water Management, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (MS). The soil was well drained, clayey in texture, low in available N (188.16 kg/ha) and medium in available P (16.45 kg P_2O_5/ha) and very high in available K (720.8 kg K_2O/ha). The experiment was carried out in strip plot design with three replications. There were total 12 treatment combinations. Four irrigation methods *viz.*, surface, subsurface irrigation through porous pipe, drip and micro-sprinkler irrigation methods assigned in one strip at East-West direction and three cropping sequences includes *suru* sugarcane, cotton-beetroot and brinjal-chilli assigned in another strip at North-South direction. Except beetroot, all crops were planted by paired row planting technique of 90-180 cm. For beetroot four row planting technique (45-90 x 10 cm) with BBF was adopted. Recommended fertilizer dose was applied for all crops involved in cropping sequences. The crops were raised with recommended agronomic package of practices.

The surface irrigation were scheduled at a depth of 8 cm on 75 mm CPE for sugarcane and cotton, at 6 cm depth on 50 mm CPE for brinjal and at 3cm depth for 25 mm CPE for beetroot and chilli. The drip and micro sprinkler operated at alternate day on the basis of CPE values. In subsurface irrigation method water was provided through approtech porous pipe through water tank. The total irrigation water applied was worked out in ha-cm. The equivalent yield of cropping sequences converted on the basis of total monetary values. The water productivity and economic efficiency were calculated by formulae as suggested by Gangwar *et al.* (2006). The production efficiency and returns per day were calculated by dividing sugarcane equivalent yield and net monetary returns, respectively, with total duration of that cropping sequence. The total mean duration of sugarcane was 350 days, for cotton-beetroot and brinjal -chill sequence respective values were 318 and 293 days. The returns per rupee invested on fertilizer and irrigation were worked out as suggested by Palaniappan and Sivaraman, (1994). The return per ha-cm of water was evaluated by dividing net monetary return (Rs/ha) with total water requirement of the respective cropping sequence. While calculating cost of fertilizers, intrest @ 12% was added. Cost of irrigation included fixed seasonal cost of irrigation system and labour charges to operate them.

RESULTS AND DISCUSSION

Effect of irrigation methods

The sugarcane equivalent yield was significantly more under drip irrigation (182.77 t/ha) than surface and subsurface irrigation method and was at par with micro-sprinkler irrigation methods (Table 1). The maximum amount of water was applied under surface irrigation methods (164.95 ha-cm). The subsurface irrigation method saved more amount of water (53.43%) followed by drip (47.06%) and micro sprinkler (29.98%) irrigation methods. The water productivity was significantly increased due to application of water through subsurface (219.50 kg/ha-mm) and drip (219.00 kg/ha-mm) irrigation methods. It was mainly due to more sugarcane equivalent yield and saving of water under said irrigation methods. These results are in conformity with findings of Shinde *et al.* (1998) and Shelke *et al.* (1999). The drip irrigation method also recorded significantly higher production efficiency (567.67 k/ha/day) over all irrigation methods due to more sugarcane equivalent yield.

In respect of economic evaluation it was observed that, the adoption of drip irrigation method significantly improved economic efficiency (Rs. 247.70/day) and returns per rupee invest on fertilizer (Rs.15.03/ha) and was at par with micro sprinkler irrigation method because of more net monetary returns and efficient utilization of applied fertilizer. Further it was noticed that, returns per day (RS. 276.84/day) and return per ha-cm of water (Rs. 1019.71/ha-cm) were significantly highest under drip irrigation method and was significantly lower under surface irrigation method. It was mainly due to drip irrigation method which yields better, received more net monetary returns with lesser amount of water application (87.31/ha-cm). These results are in agreement with findings of Manjunatha *et al.* (2004) The returns per rupee invest on irrigation was significantly lower under subsurface irrigation method due to highest fixed seasonal cost (Rs 44376/ha) involved in the installation of system (Table 1).

Effect of cropping sequences

The brinjal-chill sequence produced significantly more higher sugarcane equivalent yield (28.59 t/ha), production efficiency (777.00 kg/ha/day) over sugarcane and cotton-beet root sequence due to higher biological productivity of former sequence. The adoption of brinjal-chill sequence saving 19.89 percent water over sugarcane. The adoption of this sequence significantly increased water productivity (249.70 kg/ha-mm) as compared to sugarcane (Table 1). Though sugarcane consumed more amount of water (187.57 ha-cm) but was not able to reflect it in achieving higher wateproductivity and proportionately produced lower sugarcane equivalent yield. Similar results were reported by Nehra and Bhunia (2002) and Thombre *et al.* (2006).

Table 1. Effect of irrigation methods and cropping sequences on sugarcane equivalent yield, applied water, water productivity, production efficiency, economic efficiency, returns per rupee invested on fertilizer, returns per rupee invested on irrigation and return per ha-cm of water

Treatment	Sugarcane Equivalent Yield (t/ha)	Water applied (ha-cm)	Water use productivity (kg/ha-cm)	Production efficiency (kg/ha/ day)	Economic efficiency (Rs/day)	Returns per day (Rs/day)	Returns per rupee invest on Fertilizer (Rs/ha)	Returns per rupee invest on irrigation (Rs/ha)	Returns per ha-cm (Rs/ha-cm)
Irrigation methods									
Surface	132.90	164.96	84.50	412.50	144.21	162.93	8.80	4.91	319.50
Subsurface	162.73	76.83	219.50	498.50	152.77	170.44	11.71	1.53	720.59
Drip	182.77	87.31	219.00	567.67	247.70	276.84	15.03	4.18	1019.71
Microsprinker	169.10	115.49	151.90	524.00	211.63	234.63	12.70	3.63	649.75
SEm ±	5.24	-	23.80	15.87	12.73	13.39	1.05	0.80	73.50
CD at 5%	14.60	-	59.80	39.90	39.30	40.16	2.95	2.35	204.85
Cropping sequence									
Sugarcane	128.91	187.57	104.20	368.13	178.62	186.57	9.25	3.38	520.05
Cotton-beetroot	106.63	106.76	152.30	364.00	47.29	58.91	3.85	0.89	258.49
Brinjal-chilli	248.59	150.26	249.70	777.00	343.82	388.47	21.22	9.14	1253.68
SEm ±	12.42	-	44.00	34.77	18.79	31.69	0.40	0.62	170.09
CD at 5%	32.99	-	121.80	89.86	53.51	89.37	1.19	1.81	475.16

The economic efficiency (Rs. 343.82/day) returns per day (Rs. 388.47/day), returns per rupee invest on fertilizer (Rs. 21.22/ha) and irrigation (Rs. 9.14/ha) were significantly higher under brinjal-chill sequence followed by sugarcane suggesting that brinjal-chill sequence is economically more feasible than sugarcane. All these economical parameters were significantly lower under cotton-beetroot sequence. The return per ha-cm of water was significantly more under brinjal-chill sequence. The cotton beetroot sequence consumed lower quantity of water as well as produced lower net monetary return and was on par with sugarcane for return per ha-cm of water (Table 1).

Interaction effect

Brinjal-chilli sequence recorded significantly more sugarcane equivalent yield, water productivity and production efficiency than sugarcane and cotton beetroot sequence under all irrigation methods (Table 2). It was mainly due to higher biological productivity with lesser consumption of water (150.26 ha-cm) in 322 day by said seçuence. Cotton-beetroot sequence recorded significantly lower, production efficiency and was on par with sugarcane for water productivity under all irrigation methods. The microirrigation methods recorded significantly higher water use productivity than surface irrigation methods under all cropping sequences. The micro irrigation methods were improving micro climate in crop canopy as well as under rhizosphere which led to higher biological yield with lesser consumption of water. Similar findings are reported by Magar and Lamm (1995) and Shinde *et al.* (2004). The subsurface and drip irrigation methods significantly increased water use productivity than micro sprinkler irrigation methods under all cropping sequences. Brinjal-chilli sequence under drip irrigation method not only increased water use productivity (332-70/ha-cm) but also produced significantly more sugarcane equivalent yield (293.20/ha) and production efficiency (910.00 kg/ha/day) than other treatment combination. Therefore, it was suggested that, brinjal-chill sequence is better alternative cropping sequence to sugarcane

Table 2. Sugarcane equivalent yield, systems productivity, production efficiency and economic efficiency as influenced by interaction between irrigation methods and cropping sequences (pooled data of 2 years)

Treatment	Sugarcane equivalent yield (t/ha)			System productivity (kg/ha/day)			Production efficiency (kg/ha)			Economic efficiency (Rs/day)		
	Sugarcane	Cotton Beet-root	Brinjal chilli	Sugarcane	Cotton Beet-root	Brinjal chilli	Sugarcane	Cotton Beet-root	Brinjal chilli	Sugarcane	Cotton Beet-root	Brinjal chilli
Surface	102.98	92.13	203.60	50.00	77.80	125.60	294.00	314.50	629.00	145.69	44.15	269.30
Subsurface	134.70	106.28	241.21	142.80	198.80	316.80	384.50	363.00	748.00	136.41	38.67	281.21
Drip	138.58	116.52	293.20	128.90	195.40	332.70	396.00	397.50	910.00	215.25	69.11	458.74
Micro-sprinkler	139.39	111.57	256.35	95.00	137.00	223.80	398.00	381.00	793.00	215.10	53.74	366.03
		SEm ±	CD at 5%		SEm ±	CD at 5%		SEm ±	CD at 5%		SEm ±	CD at 5%
I x S		7.88	25.18		14.90	44.70		28.19	83.72		24.94	72.46
S xI		7.77	25.04		23.00	69.50		27.37	82.53		23.20	70.56

under drip irrigation to increase water productivity and production efficiency.

The drip and micro sprinkler irrigation methods recorded significantly morehigherurns per rupee invested on fertilizer under sugarcane and brinjal-chilli sequences. The subsurface and drip irrigation methods produced significantly higher returns per ha-cm of water than micro sprinkler irrigation under all cropping sequences. The economic efficiency, returns per day, returns per rupee invested on fertilizer and returns per ha-cm of water were significantly more in brinjal-chilli sequence under all irrigation methods (Table 3). The return per ha-cm of water was significantly highest in brinjal-chilli sequence followed by sugarcane under all irrigation methods. Thus, it is concluded that, the adoption of brinjal-chilli sequence produces significantly higher economic efficiency (Rs. 458.74 day^{-1}), returns per day (Rs. 520.00/day), return per rupee invested on fertilizer (Rs. 28.32/ha) and returns per ha-cm of water (Rs. 1852.80/ha-cm) indicating that it is economically more feasible than sugarcane under drip irrigation method.

Table 3. Returns per day, returns per rupee invested on fertilizer, returns per ha-cm of water as influenced by interaction between irrigation methods and cropping sequences

Treatment	Returns per day (Rs/ha)			Returns per Rupee invest on fertilizer (Rs/ha)			Returns per ha-cm of water (Rs/ha-cm)		
	Sugarcane	Cotton Beet-root	Brinjal chilli	Sugarcane	Cotton Beet-root	Brinjal chilli	Sugarcane	Cotton Beet-root	Brinjal chilli
Surface	152.05	34.43	302.40	7.55	2.25	16.61	262.02	86.51	609.60
Subsurface	144.42	48.17	318.74	7.17	3.15	17.36	715.47	200.88	1555.28
Drip	224.44	86.09	520.00	11.15	5.63	28.32	703.95	375.60	1852.80
Micro-sprinkler	224.20	66.95	412.74	11.15	4.37	22.58	519.17	211.80	1141.72
	SEm ±	CD at 5%		SEm ±	CD at 5%		SEm ±	CD at 5%	
I x S	36.47	108.89		1.14	3.95		43.26	118.56	
S xI	30.21	92.17		1.16	4.34		79.58	225.21	

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STUDY ON INTEGRATED NUTRIENT MANAGEMENT IN GROUNDNUT AT FARMERS FIELD

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ABSTRACT

An on farm trail was conducted in the deep black soil at farmers field in Hulkoti taluk in the Gadag district of Karnataka revealed that higher dose of fertilizer (150% of recommended dose) application had resulted in increased yield (22.8 q/ha) compared to the farmers practice of manure and fertilizer application (18.0 q/ha). The pod yield was further enhanced to 24.2 q/ha due to addition of 10 kg / ha each of ZnSO4 and FeSO4 along with recommended dose of fertilizers. However, pod yield that was obtained by micro nutrient application (10 kg each of $ZnSO_4$ and $FeSO_4$) along with fertilizer was at par with that of 150 per cent recommended dose of fertilizers. But, net return and B:C ratio were higher for the treatment that received 100 per cent recommended dose of fertilizers along with 10 kg each of $ZnSO_4$ and $FeSO_4$. Therefore, recommended dose of fertilizer along with micronutrients is essential to obtain economic yields in the black soil of Gadag district in Karnataka instead of applying only higher doses of fertilizers. The manure applied plots did not record higher net return as well as B:C ratio. N and P content in groundnut tissue increased with the 150 percent recommended dose of fertilizer application. Potassium content of the tissue remained unaffected due to fertilizer, manure and micro-nutrient application.

Key words : Calcareous black soil, groundnut, integrated nutrient management, micronutrient.

Groundnut being an important oilseed crop of the Karnataka, cover an area of 1.02 M hectare during rabi/summer and kharif season. It is grown both in black and red soils under irrigation. However, the cropped area under black soil is 80%. It is interesting to note that productivity of groundnut has decreased by 12% inspite of use of higher levels of input like fertilizers and pesticides. The average crop yields in farmers field were reported to be lower by 10 and 40 percent during kharif and summer season, respectively compared to the potential yield (Balakrishnan *et al.*, 1999). The lower productivity of groundnut is mainly attributed to poor soil fertility, unscientific irrigation and nutrient management, cultivation of local varieties and lack of scientific insect and disease management awareness among the farmers. In view of the above situation, on farm trials were conducted to develop the strategy for better nutrient management practices to maximize the groundnut yield in Gadag district of Karnataka.

MATERIALS AND METHODS

On farm trials were conducted during 2005-06 and 2006-07 at farmers field in Hulkoti taluk of Gadag district of Karnataka in a randomized block design with three replications and following nine treatments *viz.* Control, Farmers practice (half of the recommended dose of fertilizer and manure), Recommended manures and Fertilizer application, Farm yard manure@ 5 t /ha, Recommended dose of fertilizer (RDF), Manure @ 5 t/ ha + 150% RDF , 150% RDF, 100% RDF + 10 kg/ ha $ZnSO_4$ and 100% RDF + 10 kg each $ZnSO_4$ and Fe SO_4/ ha. The treatments were applied before sowing of the crop in plots. Soil samples were drawn before application of treatments and subjected to chemical analysis to estimate pH, available N,P,K, Fe and Zn. The soil of the experimental site was calcareous and deep black. The soil of the trial fields was deficient in available N (165 kg/ ha) and P (8 kg /ha) and sufficient in K (4.51 kg/ha). The available Zn and Fe were 0.4 and 4.2 mg/kg. Plant biometric parameters and yield attributes were recorded at the time of harvest on five plants and averaged for the treatment and replication. Similarly, the pod yield and straw yields were also recorded for all the treatments and replications. Whole plant samples at peak vegetative stage (40 days after sowing) were collected, washed, dried and milled for the analysis of N, P, K, Fe and Zn in plant tissue by adopting the standard analytical procedures.

RESULTS AND DISCUSSION

The results presented in Table 1 revealed that groundnut yield increased with soil application of the higher doses of fertilizers and manures. The maximum yield (24.2 q/ha) was recorded by the soil application of 100 per cent N, P and K doses along with 10 kg/ ha each of $ZNSO_4$ and $FeSO_4$. The yield obtained by application of RDF along with $ZnSO_4$ and $FeSO_4$ was significantly higher than manure or control or farmers practice of manure and fertilizer application. The soil being deficient in N, P, Fe and Zn, it is appropriate that the crop had responded to the fertilizer and micronutrient application. Similar observations of increased groundnut yields with soil application of Zn, B and S have been made by Chitdeshwari and Poomgathai (2003). Patil *et al.* (2003) had also observed significant increase in groundnut yield by soil application of Zn and Fe along with RDF in black soils of north Karnataka. However, in the present study the yield obtained by application of RDF alongwith ZnSo4 and FeSO4 was at par with that of 150% RDF. Increasing RDF to 150 per cent did not bring the higher yield than the 100 percent RDF. On par yield levels between 150% RDF and 100% RDF alongwith $ZnSO_4$ and FeSO4 might be attributed to the conversion of the applied Zn and Fe into unavailable form and eventually leading to the crop being not benefited by applied Zn and Fe. This was because of the calcareous nature of soils and high pH. Immobilization of Fe due to high Ca in soils with pH more than 8.5 and high phosphorus and HCO_3 ions in soil and irrigation water was observed by Reddy (1976). Similar soil conditions prevailing (calcareous & high pH) in the present trial site might have made both Fe and Zn immobile and non available. Moreover, the soils were not only deficient in Fe and Zn but also in N and P. Therefore, the crop has responded by recording higher yield due to the soil application of higher N and P. Hence, foliar application of Fe and Zn could be best alternative. The treatment that received only manure @ 5 t/ ha recorded lower yield (18.3 q /ha) which was at par with control (15.9 q/ ha) and RDF (21.5 q /ha). The yield attributing parameters like number of branches, and number of undeveloped branches were not affected by soil application of manures and higher dose of fertilizers including $ZnSO_4$ and $FeSO_4$ (Table 1). In the contrast to the observations made in the present study, Takkar and Nayyar (1984) reported that groundnut responded significantly by recording higher pod yields wherever soil application of Zn was practiced in alluvial soils of Andhra Pradesh, Bihar and Uttar Pradesh. The striking difference between alluvial and black soils is that latter has pH buffered at 8.4 and are calcareous. The calcareous soils render applied Zn and Fe either to co-precipitate along with $CaCo_3$ or precipitate as carbonates. Patil and Malewar (1998) have also concluded that calcareous black soils of Maharashtra were incapable to meet micro-nutrient requirement of mandarin even though soils had sufficient available Zn and Fe. The data presented in Table 1 revealed that only N and P composition of the plant tissue varied but not K, Fe and Zn due to different treatments. The N and P content of plant tissue were significantly higher in the plots that received 150 per cent RDF with farm yard manure. However, the tissue concentration of N and P with 150% RDF was on par with 100% RDF + $ZnSO_4$ and $FeSO_4$ indicating of Zn and Fe had no influence on the N and P uptake and accumulation in plant tissue. Rao and Narayan (1991) noticed that many groundnut cultivars recorded higher uptake and accumulation of N and P due to application of higher doses of N and P. Similarly, Singh *et al.* (1995) carried out an experiment on groundnut in black calcareous soil with normal and excess irrigation, and observed higher content of N and P in the plant tissue due to increased doses of fertilizers. However, the present trial, in contrast to N and P, the tissue concentration of K, Fe and Zn remained unchanged due to higher level of N, P, K, Fe and Zn application to soil. This is due to the fact that soil was high in K, pH and calcium.

Therefore, the plants could not be benefited by soil application of Fe and Zn due to the above mentioned reasons. The net returns (Rs. 25,695) and B:C ratio (2.59) obtained in this trial were the best for the treatment that included 100% RDF alongwith 10 kg/ha each $ZnSO_4$ and $FeSO_4$ and without organic manures. This clearly indicated that application of RDF alongwith $ZnSO_4$ and $FeSO_4$ was sufficient to realize maximum economical benefit from groundnut in the north Karnataka. However, the pod yields were on par between 100% RDF and 100% RDF alongwith $ZnSO_4$ and $FeSO_4$. The second highest B:C ratio was realized for the treatment that had no manure but 100% RDF alongwith 10kg/ ha $ZnSO_4$ only. Therefore, it is inevitable to apply both ZnSO4 and FeSO4 along with RDF to obtain the maximum economical benefits from the groundnut crop under north Karnataka conditions.

Table 1. Effect of manure, fertilizers and micronutrients application on growth, yield and nutrient content of groundnut (Mean of two years)

Treatments	Plant height (cm)	No.of branches	No.of developed pods	No.of undeveloped pods	Pod yield (q/ha)	Straw yield (t/ha)	Nutrient content in the tissue				
							N (%)	P (%)	K (%)	Fe (ppm)	Zn (ppm)
Control	21.1	4.8	8.4	4.4	15.9	3.5	3.64	0.311	3.00	466	17.6
Farmers practice of manure & fertilizer	22.7	5.4	10.5	5.0	18.0	4.3	3.86	0.314	2.64	382	18.3
Recommended manure & fertilizer	24.7	5.3	11.2	5.0	19.7	4.7	4.07	0.345	3.24	502	16.7
Manure @ 5 t/ ha	23.0	5.1	10.8	4.4	18.3	4.9	3.71	0.295	3.33	475	15.5
Recommended dose of fertilizer (RDF)	25.0	5.1	10.2	4.4	21.5	4.9	4.11	0.339	3.27	518	18.8
Manure @5 tha^{-1} + 150% RDF	23.2	5.0	8.3	5.1	22.5	5.1	4.40	0.371	3.54	500	19.4
150% RDF	25.2	5.5	11.8	3.9	22.8	5.4	4.33	0.377	3.39	536	18.7
100% RDF + 10kg/ha Zn So_4	24.1	5.3	11.6	5.0	23.4	5.0	4.22	0.349	3.12	532	21.8
100% RDF + 10kg/ ha each $ZnSO_4$ & Fe SO_4	23.7	5.4	11.3	4.6	24.2	5.4	4.07	0.345	3.27	564	21.3
CD at 5%	2.5	NS	3.1	NS	4.2	1.8	0.32	0.058	NS	NS	NS

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RESPONSE OF RAJMASH GENOTYPES TO FERTILIZER LEVELS IN KARNATAKA DURING *RABI*

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The progressive decline in per capita availability of pulses in India is a matter of great concern to alleviate protein energy malnutrition. To make up this shortfall in supply besides further demand from burgeoning population about 20 million tons of pulses are required. An estimated 2.5 million ha additional area can be brought under different pulses through different measures. Introduction of non-conventional pulses in new areas is one of the ways to step up the production of food legumes. French bean is grown in Karnataka as a vegetable crop. As a pulse crop it is new to this area. Since the package for high productivity developed for vegetable French bean may not be applicable to grain crop, this study was undertaken to know the suitable varieties of French bean and their response to fertilizer doses during *rabi* when they are grown for grain purpose.

The experiment was conducted at Main Agricultural Research Station, Dharwad during *rabi* season of 2004 under rainfed condition. The treatments comprised of 4 genotypes (Vaghya, Contender, HPR-35 and Arka Komal) and 3 levels of fertilizer (50%, 100% and 150% of RDF). Recommended dose of fertilizer for French bean is 62.5:100:75 kg of N:P2O5:K_2O/ha. The experiment was laid out in a randomized block design with three replications. The soil was clay loam with pH 7.2 available N, P_2O_5 and K_2O of 212.7, 31.74 and 326.2 kg/ha, respectively. The soil was having 0.52% organic carbon.

Among the varieties, HPR-35 and Contender were significantly superior (1833 and 1666 kg ha^{-1}) over others with respect to grain yield. Variety HPR-35 recorded 10, 36 and 57 percent higher yield over Contender, Arka Komal and Vaghya. Number of pods and 100 seed weight were also significantly higher in HPR-35 and Contender, when compared with others. Singh and Yadav (1986), reported that number of pods/plant determine the grain yield in pulses to a considerable extent.

Table 1. Effect of varieties and fertilizer levels on yield and yield parameters of French bean

Treatment	Number of pods/plant	100 Seed weight (g)	Seed yield (kg/ha)
Varieties			
Vaghya	7.91	29.80	1163
Contender	10.16	33.43	1666
HPR-35	11.01	34.56	1833
Arka Komal	8.89	29.92	1339
SEm±	0.45	0.68	72
CD at 5%	1.32	1.99	211
Fertilizer doses			
50% RDF	8.65	29.32	1172
100% RDF	9.96	30.91	1599
150% RDF	10.14	31.23	1730
SEm±	0.36	0.52	62
CD at 5%	1.05	1.52	183

Fertilizer levels differed significantly in grain yield, number of pods and 100 seed weight. Recommended dose of fertilizer (100%) was on par with that of 150% RDF in grain yield. Reduction of fertilizer level to 50% RDF reduced the yield of French bean significantly when compared with 100 and 150% RDF. The results are in agreement with that of Verma and Saxena (1995). Interaction effect was not significant in yield and yield parameters.

Varieties HPR-35 and Contender can be grown for grain purpose with the recommended dose of fertilizer during *rabi* in northern transition zone of Karnataka.

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FRUIT CRACKING AND YIELD OF POMEGRANATE AS AFFECTED BY BORAX WITH IRRIGATION AT DIFFERENT INTERVALS

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Pomegranate (*Punica granalurn* L.) is considered as an important fruit crop of arid and semi-arid regions because of it's hardy nature, versatile adaptability and export potential. It is grown for it's cool and refreshing juice. Some of the major physiological disorders which adversely affect the production and quality of pomegranate are fruit cracking, internal breakdown and sun- scorching. The mature fruits are invaded by certain fungi or bacteria, once they get cracked. This leads to loss of market value and often makes the invaded fruit unfit for human consumption (Panwar *et al.*, 1994; Singh, 1995). Seveal studies are found on the individual effect of irrigation, gibberellic acid or borax on fruit cracking of pomegranate (Anonymous, 1993; Sharifi and Sepahi, 1984), but very less information is available on combined effect of these factors on cracking. The present experiment was undertaken to see the response of borax with different irrigation intervals on fruit cracking and yield of pomegranate.

Ten-year-old pomegranate trees cv. Ganesh at a farmer's field were taken for study where 30 kg farm yard manure (FYM), 0.75 kg urea, 130 g super-phosphate and 170 g muriate of potash per plant were applied in the month of May 2004, irrigation was given at 9, 14 and 20 days interval to control fruit cracking. Borax @ 0.75% and 1.25% was applied in the soil alone and in combination with the above irrigation intervals at the time of fruit setting. Plants with irregular irrigation and without borax were treated as control. Observations on plant height, number of fruit per plant, cracked fruits per plant, average fruit weight and yield were recorded at the time of maturity and harvest.

Table 1. Effect of borax and irrigation intervals on yield and yield attributies in pomegranate

Treatment	Plant height (m)	Fruits per plant	Cracked fruits per plant (%)	Average fruits plant	Average fruits plant
Control (Irregular irrigation without Borax)	2.83	36.35	20.35	210.31	7.64
Irrigation at 9 days	3.11	38.35	19.35	211.65	8.11
Irrigation at 14 days	3.35	37.33	11.01	232.02	8.66
Irrigation at 20 days	3.03	38.32	8.99	230.01	8.81
Borax 0.75%	3.47	40.32	9.35	236.66	9.54
Borax 1.25%	3.51	41.79	8.32	260.15	10.92
Irrigation at 9 days + 0.75% borax	3.85	43.88	5.67	305.66	13.41
Irrigation at 14 days + 0.75% borax	3.53	34.65	2.01	304.99	10.75
Irrigation at 20 days + 0.75% borax	3.59	35.32	7.65	262.35	9.26
Irrigation at 9 days +125% borax	3.71	38.66	5.32	294.01	11.36
Irrigation at 14 days + 1.25% borax	3.62	38.66	7.99	269.98	10.44
Irrigation at 20 days +1.25% borax	3.77	43.65	5.67	250.01	10.91
SEm±	0.28	1.92	1.76	25.95	0.13
CD at 5%	NS	5.56	5.13	75.12	0.36

Results showed that adjustment of irrigation intervals and application of borax alone or in combination generally increased the plant height, which was statistically non-significant. Number of fruits per plant increased significantly with 0.75% borax + 9 days of irrigation interval, followed by 1 .25% borax + 20 days of irrigation interval. Average fruit weight also increased with almost all the treatments, the most effective being irrigation at nine days interval + 0.75% borax. These observations further indicated that isolated treatments of different irrigation intervals (9, 14 and 20 days) and borax concentration (0.75 and 1.25%) increased the fruit weight and number of fruit to some extent, but combinations of these treatments provided higher yield (Table 1). Further, a significant decrease in per cent fruit cracking with these treatments was also recorded The role of borax and irrigation interval in increasing fruit set and fruit retention have been reported by other workers also (Anonymous, 1993; Kamble *et al.*, 1994).

Thus, soil application of 0.75% borax at the time of fruit setting, and irrigation at nine days interval decreased the fruit cracking and improved the yield in pomegranate.

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EFFECT OF IRRIGATION LEVELS AND WEED MANAGEMENT ON PRODUCTIVITY OF WHEAT (*TRITICUM AESTIVUM*, L.) UNDER ZERO TILLAGE

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Lately, there has been great emphasis on the use of 'resource conservation technologies' in raising field crops for saving natural resources for posterity. Adoption of zero-tillage in wheat crop is one such practice which has gained popularity in the recent past. Irrigation increases the availability of water and nutrients through the establishment of relatively favorable moisture conditions around root zone of crop. Hoowever, the research work done on irrigation scheduling of wheat crop raised under zero-tillage system is very negligible. Weeds have been recognized as serious menace to wheat production. Most of wheat in India is grown under irrigated conditions, which serve the weeds a suitable habitat. Weed menace in wheat crop in particular is more severe when the crop is raised with zero-tillage system. Hence, there is a need to work out suitable irrigation scheduling and weed management practice for wheat crop raised under zero-tillage situation. Keeping this in view, the present experiment was carried out during *rabi*, 2007-08 at the Instructional Farm, Department of Agronomy, RCA, Udaipur. The experiment comprised combinations of four levels of irrigation based on IW/CPE ratio (0.5. 0.75, 1 .0 and 1 .25 IW/CPE with 6 cm water) in main plots and four weed control methods (weedy check, pendimethalin at 0.75 kg/ha as pre-emergence, combination of 2.4-D at 0.4kg/ha + isoproturon at 0.6 kg/ha as post- emergence and manual weeding at 35 DAS) in sub plots, replicated thrice. The soil was clay loam, medium in nitrogen, high in available phosphorus as well as potassium. All the plots received pre-sowing irrigation. Each irrigation was of 60 mm depth. The total number of irrigation including the pre-sowing under 0.5.

Table 1. Effect of irrigation levels and weed control practices on yield attributes, yield, consumptive use and water use efficiency of wheat crop

Treatments	Effective tillers/m^2	Number of grains /year	Test weight (g)	Grain yield (t/ha)	Biological yield (t/ha)	Consumptive use (mm)	WUE (kg/ha -mm)	Weed dry matter (kg/ha)
Irrigation levels (IW/CPE)								
0.5	307.41	31.48	33.45	3.44	7.96	162.75	21.17	603.57
0.75	345.16	34.06	35.78	3.49	8.10	210.33	16.65	760.35
1.0	389.08	37.51	38.35	4.57	10.72	268.67	17.10	861.76
1.25	393.41	37.80	38.65	4.71	11.00	353.25	12.76	940.10
CD (p=0.5)	31.80	2.30	2.47	0.29	0.95	30.72	1.24	1.71
Weed control								
Weedy check	330.91	33.88	34.20	3.83	9.05	249.08	15.18	15.00
Pendimethalin	342.33	34.51	35.35	3.87	9.15	257.42	15.88	11.32
IPU+2,4-D	374.08	36.08	38.02	4.24	9.77	246.33	18.04	7.66
Manual weeding	387.75	36.38	38.66	4.27	9.83	242.17	18.58	7.67
CD (p=0.5)	21.49	1.49	1.57	0.22	0.35	NS	1.03	0.90

0.75, 1.0 and 1 .25 IW/CPE ratios were 4,5, 6 and 8, respectively. Pendimethalin was applied as pre-emergence while a combination of 2,4-D+Isoproturon was applied a post-emergence treatment.

The results (Table 1) showed that varying irrigation levels from 0.5 to 1.25 IW/CPE recorded increases in weed dry matter. Irrigation at 1.25 IW/CPE with 6 cm was observed at par with 1 .0 IW/CPE and both these levels recorded significantly higher number of effective tillers/m, number of grains per ear, test weight of grains, grain and biological yield and consumptive use over irrigation at 0.5 and 0.75 IW/CPE. Whereas, water use efficiency was significantly the highest at 0.5 IW/CPE. The findings are in agreement with the findings of Singh *et al.* (2006). Application of combination of 2,4-D (0.4 k/ha) Isoproturon (0.6 kg/ha) was observed at par with manual weeding at 35 DAS and both these weed control treatments significantly reduced weed dry matter at harvest but gave significant increases in number of effective tillers m^2, number of grains per ear, test weight of grains, grain and biological yield, consumptive use and water use efficiency over weedy check and application of pendimethalin. Jain *et al.* (2007) also reported almost similar results with regard to effect of combination of 2, 4-D + isoproturon on weed dry matter and productivity of wheat crop.

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ASSESSMENT OF DRUM SEEDER ON DIRECT SEEDED RICE (*ORYZA SATIVA*) UNDER PUDDLED CONDITION

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Transplanting is common practice in rice cultivation in Bihar. The cultivation of rice is generally delayed due to seedling raising and transplanting. The technology of drum seeded rice is gradually adopted by the farmers of Bihar. In the district Jamui, there is an urgent need to judge the appropriate practices for of drum seeded rice technology.

It reduces cost of cultivation and time with effective weed management practices. Transplantation alone costs about 15% of total rice production cost and delayed planting due to labour shortage causes substantial loss in yield (Poonuswamy *et al.*, 1999)

Transplanting also enhance the crop duration by 7-10 days. This technology reduce the labour cost and time of conventional practices by using 12 row drum seeder and the efficiency of technology can compare with traditional rice cultivation practices.

A trail was carried out during the kharif season of 2006 and 2007 at Kundri, Jamui (Bihar) under clay loam soil with pH 6.8, organic carbon 0.46% and available N ($KMnO_4$), P (Olsen) and K (NH_4OH method) content of 279, 16 and 180 kg/ha, respectively. The rice variety Raj. Mansuri was used. The trial consisted three treatments *viz.* conventational method (80 kg seed/ha+ hand weeding at 30 and 45 days after planting +soil test based fertilizer dose $ZnSO_4$ 25 kg/ha broadcasting 100 kg (T_1) seed/ha + hand weeding at 30 and 45 days after seeding + soil test based fertilizer dose + $ZnSO_4$ 25 kg/ha (T_2) and seeding of 56 kg sprouted seed/ha with 12 row drum seeder two days after puddling +weed control through pretlachlor @ 0.5 kg ai/ha + soil test based fertilizer dose + $ZnSO_4$ 25 kg/h (T_3).

The trial was laid out in randomized block design with sixteen replications. The agro-ecological situation of low land canal irrigated. The plot size of each replication was 0.25 ha. The direct seeded rice sowing was done during second week of June for both the years. Seeding for nursery was also done on the same day after 28 days seedling was transplanted in T_1. Sprouted seed of rice was sown at a distance of 20 cm from line to line in puddle field in second week of June for both the years. The entire dose of P, K and $ZnSO_4$ were applied as basal. Nitrogen was applied in three splits, i.e 50, 25 and 25 % as basal, tillering and panicle initiation stages, respectively. Grain and straw yields for the whole plots were taken after crop harvest and converted to t/ha. Cost of cultivation and return for each treatment were calculated/ha on the prevailing cost of inputs at market prices.

The highest tillers/m² and panicle/m² were with T_3. However this treatment (T_3) was at par

Table 1. Yield and economics of rice influenced by seeding method under puddled condition

Treatment	Max tiller/m²		Panicle/m²		Grain yield t/ha		Straw yield t/ha		1000 grain Wt. (g)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
T_1	396	403	353	376	4.2	4.40	6.42	6.87	22.0	22.3
T_2	378	398	309	330	3.8	3.76	6.2	5.86	20.9	21.2
T_3	439	442	389	405	4.8	5.10	7.2	8.40	22.8	23.1
CD	23.6	30.2	25.8	29.3	0.16	0.21	0.27	0.21	NS	NS

with conventational method T_1 in respect of yield attributes. The lowest tiller/m^2 and panicle/m^2 were obsereved with T_2.

The highest grain and straw yield was recorded in T_3 followed by T_2 and T_1, respectively. The highest net return was recorded with T_3 followed by T_1 during both the years. It may be due to higher grain yield and lower cost of cultivation. Use of 12 row drum seeder reduced expenditure on labour. Broadcasting recorded the lowest net return (Table 1).The highest benefit: cost ratio was recorded with T_3 in both the years.

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